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ABSTRACT

This guide facilitates and promotes awareness, appreciation, and knowledge of North Dakota's wetland resources. It is an interdisciplinary wetland activity guide for kindergarten through 12th grade teachers. It was developed specifically for North Dakota educators by North Dakota education and natural resource professionals about North Dakota's wetland resources. This guide integrates the curriculum goals for science, social studies, geography, mathematics, North Dakota studies, English/language arts, and art. Each activity contains abstract reference information about intended age level, subject area, duration, group size, teaching settings, skills, North Dakota curriculum references, and key vocabulary. Information is provided about intended learning outcomes, rationale for the activity, necessary student prior knowledge, background information, list of materials needed to conduct the activity, step-by-step procedures, activity extensions, evaluation methods, and material reference information. The appendices contain a list of skills, North Dakota curriculum frameworks reference list, information about North Dakota agencies and organizations associated with wetlands conservation, and information about major wetland protection efforts. Also includes a glossary. (AIM)

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North Dakota Wetlands Discovery Guide

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North Dakota Wetlands Discovery Guide

Activities for Elementary and Secondary Educators

Edited and Compiled by

Nancy J. Dietz, BlueStem Incorporated

with assistance from

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July 1995

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INTRODUCTION

If you ask fellow North Dakotans about a "wetland," you may be surprised at the diversity of responses you receive. Because wetlands or prairie potholes are products of our state's geologic past, you can be assured the state's residents will continue to address this resource in many ways. In the past 50 years, society's view of wetlands has changed from "draining as many wetlands as possible," to "preserving and restoring wetlands." In the same respect, farmers were once paid to drain wetlands, and now remaining wetland are regulated by local, state and national laws. This change in attitude has resulted from improved scientific understanding of the important functions wetlands perform in the environment. With this improved understanding, society now realizes the valuable benefits wetlands provide. Because North Dakota has a bounty of wetlands, it is important that the next generation of North Dakotans learn about our state's wetland resources so that they have the skills to make informed decisions about their state's future.

The *North Dakota Wetlands Discovery Guide (Guide)* is intended to facilitate and promote awareness, appreciation, and knowledge of North Dakota's wetland resources. The *Guide* is an interdisciplinary wetland activity guide for kindergarten through twelfth grade educators. The *Guide* was developed specifically for North Dakota educators, by North Dakota education and natural resource professionals, and about North Dakota's wetland resources.

The majority of activities found in the *Guide* were written and developed by sixteen North Dakota education and natural resource professionals. The activity development continued with preparation of draft activities. These draft activities were then tested by more than 50 teachers in their classrooms. Upon conclusion of testing, the activities were revised again. It is due to the generosity, cooperation, and recommendations of the acknowledged educators that the *Guide* is applicable and usable for North Dakota teachers.

The *North Dakota Wetlands Discovery Guide* is presented in the North Dakota Water Education for Teachers (WET) three-ring binder to provide the flexibility of adding supplementary material as new information is released. In addition, users may wish to add materials that they find helpful in teaching these activities. This format also provides the flexibility to mail teachers newly developed activities as they become available. The North Dakota Wetlands Institute (Institute), the publisher of the *Guide*, will maintain a mailing list of *Guide* copy holders. This is necessary so that you can receive supplementary materials, or new activities as they become available. The Institute will continue to enhance the *Guide* by providing current information and applicable activities to aid students in learning about their state and its natural resources. Anyone with suggestions about improving the current activities, recommendations about supplementary information, or ideas about new activities to add to the *Guide* may contact the North Dakota Wetlands Institute, 1501 North 12th Street, Bismarck, ND 58501, or call (701) 223-8332. The Institute is a division of the North Dakota Water Education Foundation.

WETLANDS DISCOVERY
HOW TO USE THE GUIDE

North Dakota's wetland resources are important from local, state, regional, national and international perspectives. Because of this importance, it is critical that future North Dakotans learn about their state's wetland resources.

Teaching about wetlands fit well into curriculum goals for science, social studies, geography, mathematics, North Dakota studies and even English/language arts and art. Each activity in the *Guide* is cross-referenced to the recently developed statewide North Dakota Curriculum Frameworks prepared by the Department of Public Instruction (Appendix A). This cross-reference is intended to provide educators a guide of how these activities can fit into their school district's curriculum.

Integrating wetlands education materials into curriculums can be accomplished in several ways. The instructor can review the activities in the *Guide* to determine which individual activities will relate to or supplement their current curriculum and teaching units. For example, if you teach a unit on soils, you could use Wetland Soils Analysis to demonstrate how soils help determine where wetlands are located. Or, if you're teaching a unit on citizen participation, use Wetland Debate to involve your students in a local land use issue. However, the best way to integrate wetland education materials is to present a three, five, or seven day wetland unit to your students. A teaching unit specific to wetlands will provide students with well-rounded information about the state's wetland resources. The Planning Guide contains recommendations of wetland units to be used. Within these units, you can demonstrate what wetlands are, terminology associated with wetlands, how wetlands function in the environment, and what values wetlands provide to society.

Because of the number of wetlands found in our state, a wetland classroom is often within walking distance of most schools. I strongly encourage teachers to bring their students to a wetland to learn more about how wetlands function in North Dakota's natural and human environment. Providing students with the opportunity for hands-on field study of a wetland is important, and increases learning. A special prairie wetlands field unit can be found in the Planning Guide.

As you review the Table of Contents, please note that beneath each activity title is a brief summary of what the activity is about and the age level for which it is intended. Each activity contains abstract reference information about intended age level, subject area, duration, group size, teaching setting, skills, North Dakota curriculum reference, and key vocabulary. In the main body of the activity there is information about intended learning outcomes, rationale for the activity, student prior knowledge needed, background information, list of materials needed to conduct the activity, step-by-step procedures, activity extensions, evaluation methods, and material reference information.

The appendices contain a list of skills, glossary of terms, North Dakota curriculum frameworks reference list, information about North Dakota agencies and organizations associated with wetlands conservation, and information about major wetland protection efforts.

PLANNING GUIDE

RECOMMENDED WETLAND TEACHING UNITS

The following are recommended 3, 5, 7 days or longer wetland teaching units. In addition, a special Prairie Wetlands Field Unit is provided, for those educators that teach a Field Biology course. A majority of the activities in the *Guide* can be adapted for use with ages above or below the recommended ages. The activities can be used either independently in association with other units you teach, in one of the recommended wetland teaching units below, or in a wetland teaching unit of your own making.

A wetland teaching unit of 5 or more days would give students the best breadth of knowledge about North Dakota's wetland resources. Keep in mind that a wetland unit could be taught across discipline areas, so involve other discipline educators in teaching the wetland unit.

Grades K - 3: Three day unit	Grades K - 3: Five day unit
"Pin the Cattail on the Wetland" *"Wetland Metaphors"* *"Wetlands in Disguise"*	*All the activities in the three day unit plus:* *"Show Your Colors"* *"Erosional Forces"* *"Wetland Soils Analysis"* *"Not in My Yard"*

Grades 4 - 6: Three day unit	Grades 4 - 6: Five day unit
"Call It What You Will"/"Witty Words on Wetlands" *"Ice in Motion"* *"Wetland Metaphors"* *"Pin the Cattail on the Wetland"*	*"Call It What You Will"/"Witty Words on Wetlands"* *"It's Downhill from Here" or "Putting on the Map"* *"To Add or Not to Add" or "Can It"* *"Wetland Models" or "Water In Water Out" and "Erosional Forces"* *"Those that Float" or "Dichotomous Plant Game"* *"Wetlands in Disguise" or "Not in My Yard"* *"Migration Headache" or "Show Your Colors"*

Grades 4 - 6: Seven days or longer unit
"Call It What You Will"/"Witty Words on Wetlands" *"It's Downhill from Here" or "Putting on the Map"* *"Ice in Motion"* *"To Add or Not to Add" or "Can It"* *"Wetland Models" or "Water In Water Out" and "Erosional Forces"* *"Those that Float" or "Dichotomous Plant Game"* *"Wetlands in Disguise" or "Not in My Yard"* *"Migration Headache" or "Show Your Colors"* *"Wetland Soils Analysis"* *"Wetland Debate"*

Grades 7 - 9: Three day unit	Grades 7 - 9: Five day unit
"Call It What You Will"/"Witty Words on Wetlands" *"Ice in Motion"* *"Wetland Metaphors"* *"Farming Wetlands" or "Wetland Debate"*	*"It's Downhill from Here" or "Putting on the Map"* *"Ice in Motion"* *"Wetland Metaphors"* *"Who Lives Here?"* *"Those that Float" or "Migration Headache"* *"Wetland Soils Analysis"* *"Farming Wetlands" or "Wetland Debate"*

Grades 7 - 9: Seven days or longer unit
"It's Downhill from Here" or "Putting on the Map" *"Ice in Motion"* *"To Add or Not to Add" or "Can It"* *"Wetland Models" or "Water In Water Out" and "Erosional Forces"* *"Who Lives Here?"* *"Those that Float" or "Migration Headache"* *"Wetlands in Disguise" or "Not in My Yard"* *"Dichotomous Plant Game" or "Algae Survey"* *"Wetland Soils Analysis"* *"Wetland Debate"* *"Farming Wetlands"*

Grades 10 - 12: Three day unit	Grades 10 - 12: Five day unit
"Ice in Motion" *"Wetland Metaphors"* *"Who Lives Here?"* *"Wetland Debate" or "Farming Wetlands"*	*"Ice in Motion"* *"To Add or Not to Add" or "Can It"* *"Wetland Models" or "Water In Water Out" and "Erosional Forces"* *"Who Lives Here?"* *"Those that Float" or "Migration Headache" or "Wetland Soils Analysis"* *"Wetland Debate" or "Farming Wetlands"*

Grades 10 - 12: Seven days or longer unit	**PRAIRIE WETLANDS FIELD UNIT**
"Ice in Motion" *"To Add or Not to Add" or "Can It"* *"Wetland Models" or "Water In Water Out" and "Erosional Forces"* *"Who Lives Here?"* *"Those that Float" or "Migration Headache"* *"Dichotomous Plant Game"* *"Wetland Soils Analysis"* *"Algae Survey"* *"Conducting an Algal Survey"* *"Farming Wetlands"* *"Wetland Debate"*	Grades 9 - 12: 7 days or longer *"Ice in Motion"* *"Wetland Soils Analysis"* *"Wetland Models"* *"To Add or Not to Add" or "Can It"* *"Who Lives Here?"* *"Those that Float and Those that Don't"* *"Algae Survey"* *"Conducting an Algal Survey"* *"Dichotomous Plant Game"* *"Migration Headache"*

North Dakota Wetlands

"The entire face of the country is covered with these shallow lakes, ponds and puddles, many of which are, however, dry or undergoing a process of gradual drying out."

These were the words of Charles Froebel, a member of General Alfred Sully's 1865 expedition, as he looked over Dakota Territory near the James and Sheyenne Rivers.

This *Guide* is about North Dakota wetlands. More commonly known as potholes, sloughs, wet spots, ponds or marshes.

What is a wetland? Very simply, it is a basin that holds water, perhaps only for a few days or as long as several months. Some wetlands are dry more than they are wet and some are wet year-round. Most depend on precipitation for their source of water, so the same wetland may be dry one summer and wet throughout the entire next summer. Because wetlands naturally go through dry and wet cycles, they produce ducks one year and are farmed another year.

The teacher background information provides some basic information about North Dakota wetlands. Included is a brief explanation of how wetlands were formed and a description of some of their functions and characteristics.

TEACHER BACKGROUND

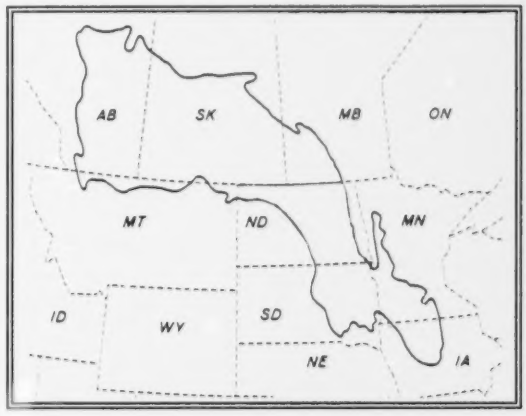
A BRIEF HISTORY OF NORTH DAKOTA WETLANDS

Glaciers that covered North Dakota for thousands of years had a hand in creating the landscape as we see it today. The last glacier covered what is now the eastern two-thirds of North Dakota 13,000 years ago. As it, retreated it left scars, depressions, and sometimes large accumulations of debris, creating the prairie pothole region. The region is known for its rolling hills and millions of small depressions, ponds and lakes. These depressions are also known as wetlands, sloughs, potholes, and marshes.

The prairie pothole region covers more than North Dakota. It includes parts of Minnesota, South Dakota, Montana, Iowa, Saskatchewan, Manitoba and Alberta. This region's unique landscape provides critical breeding habitat for more than one-half of the continent's waterfowl.

Wetlands are abundant in other parts of the country also. There are swamps, bogs and costal salt marshes elsewhere in the continent. But, prairie potholes are unique.

A simple definition of a prairie pothole or wetland is a low lying area that collects water or intersects the water table, or an area of transition between upland and permanent open water. The scientific definition of a wetland is an area that has predominantly hydric (wet) soils and is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances does support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions.



Prairie Pothole Region

PRAIRIE POTHOLES COMPLEXITY:

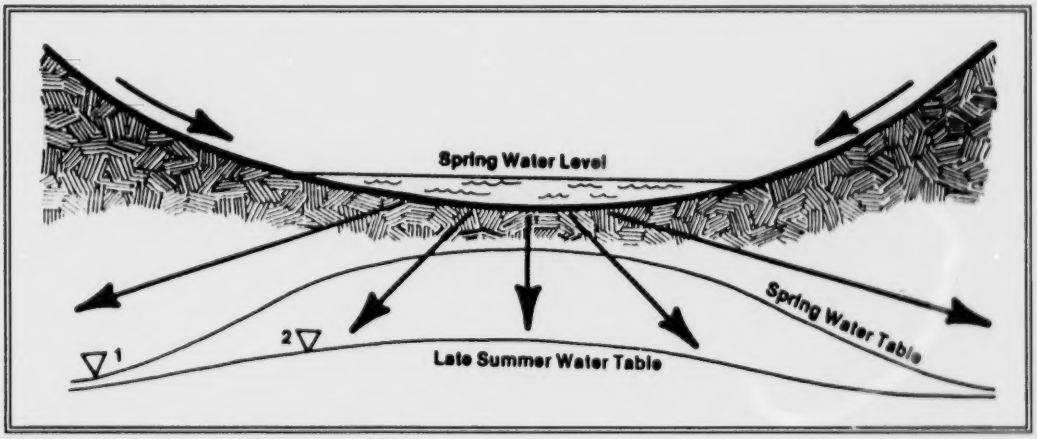
Because prairie potholes are wetlands of the prairie, their character mirrors that of the prairie - constantly changing from season to season and from year to year. Dry one year, a prairie pothole might be damp the next and wet the following.

Generally, prairie potholes receive water from snow and rain, so they will fluctuate in response to wet and dry cycles. Some potholes, however, are fed by groundwater and have a more stable water level. These groundwater-fed wetlands will go dry when the groundwater table drops, which is especially noticeable during years of extended drought.

Plants and animals of prairie potholes are adapted to these extreme conditions and the fluctuating dry and wet cycles. Wetlands have a natural seed bank of plants. The bank contains seeds of plants that thrive in deep water, along with those that survive in shallow water, and those that emerge and grow when the basin is dry. Animals that use these plants for food and shelter also change as the wetland depth and plants change. Thus, each pothole has its own complement of plants and animals in response to water conditions.

Prairie potholes are also affected by the groundwater system. For example, saline wetlands found at the low position of a closed basin have no natural outflow and accumulate salts, sometimes creating potholes saltier than the ocean. Fresh water wetlands fed mostly by surface water have natural outflow areas, allowing them to stay fresher than those with no outflow. This complex system of groundwater and surface flow contributes to the many wetland types of the region.

Precipitation, groundwater, climate, and the variety of plants and animals have created a great diversity of wetland types in the prairie pothole region. This smorgasbord of habitat and food is why the prairie pothole region is so attractive to migratory birds and other animals.



Prairie pothole groundwater recharge.

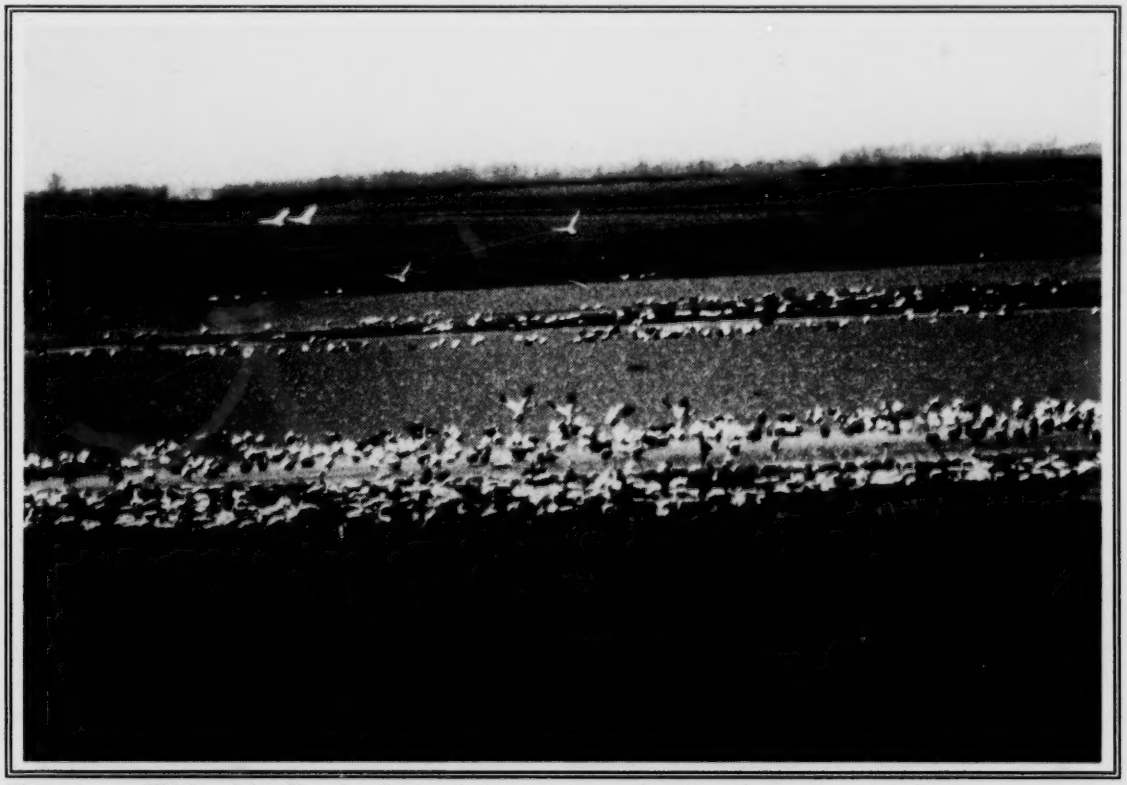
WETLAND TYPES

Wetland scientists, managers, and policy makers sort the many different kinds of wetlands into wetland classifications. These classifications provide a common ground for communication and management purposes. Because no two wetlands are exactly the same, it is often difficult to classify wetlands into less than a dozen types. For this reason, wetland classifications change as more is learned about wetlands.

Typically, a wetland fits into a particular type if it has certain characteristics. Prairie potholes are typed according to their water permanency, quality and their plant cover.

TEMPORARY WETLAND

A "temporary wetland" is a shallow depressional area which holds water or is waterlogged from spring run-off until early June. In years of normal run-off and precipitation, temporary wetland areas may be tilled for crop production. In years of high run-off or heavy spring rain, these areas may not dry out until mid-July and would not be tilled but may be used for hayland or pasture. Temporary wetlands frequently re-flood during heavy summer and fall rains.



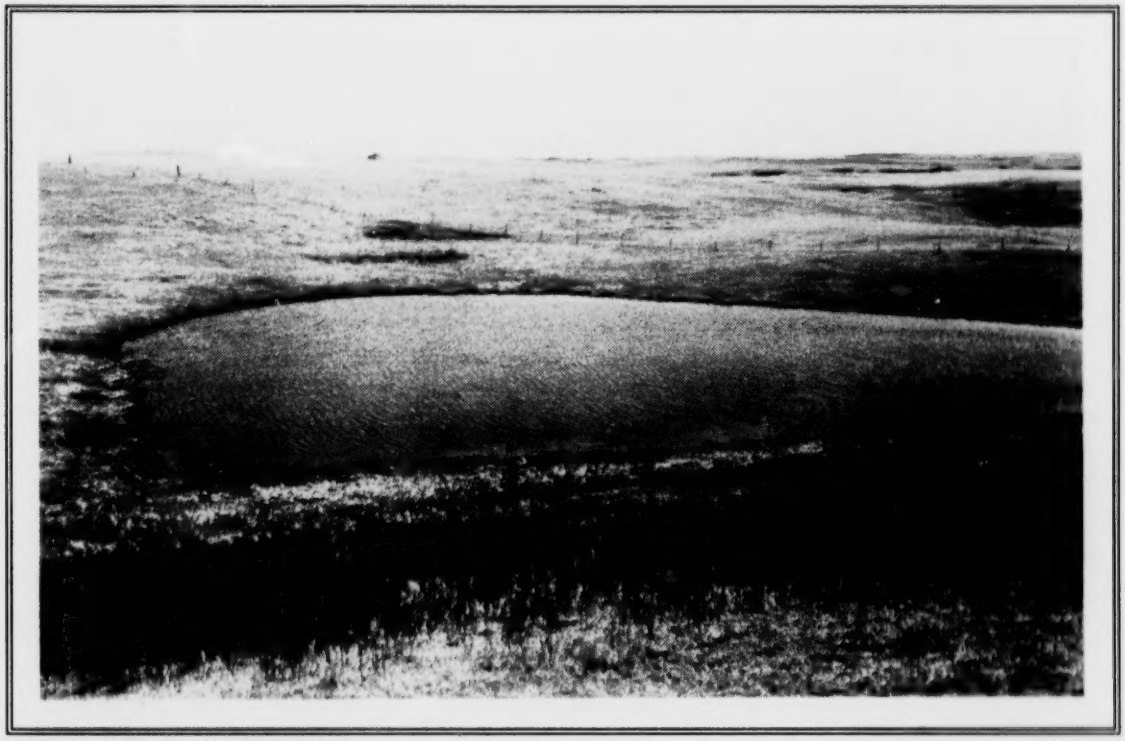
Temporary Wetland in Cropland, receiving use in spring by migratory waterfowl

Temporary Wetland in Pasture

Temporary Wetland, Cropped

SEASONAL WETLAND

A "seasonal (shallow) wetland" means a depression which holds water in normal years from spring run-off until mid-July. In years of normal run-off and precipitation, seasonal wetlands may not be tilled but can be used for hayland or pasture. In low run-off or dry years, these areas may be tilled for crop production, but commonly re-flood with frequent or heavy summer or fall rains.



Seasonal Wetland, Grazed

Seasonal Wetland

Seasonal Wetland, Cropped

SEMIPERMANENT WETLAND

A "semipermanent (intermittent) wetland" is a well-defined depression or basin which holds water in normal years throughout the summer. Semipermanent wetlands generally go dry only in years of below-normal run-off and precipitation. Freshwater semipermanent wetlands, commonly referred to as cattail sloughs, are characterized by a predominance of cattail and bulrush vegetation with scattered open water areas. Saline semipermanent wetlands are characterized by a predominance of alkali bulrush and scattered open water areas.

Semipermanent Wetland - Typical Cattail Marsh

Semipermanent Wetland - Bulrush Dominant Vegetation

Semipermanent Wetland - In Dry Period

PERMANENT WETLAND

A "permanent wetland" is a well-defined basin which characteristically holds water throughout the year. Permanent wetlands go dry only after successive years of below normal run-off and precipitation. Freshwater permanent wetlands typically have a border of aquatic vegetation and a predominant open water area in the interior. Saline permanent wetlands are typically devoid of emergent vegetation and exhibit a white, salt encrusted shoreline.

Large Permanent Wetland

FUNCTIONAL VALUES

Wetlands have other values to people of the state, for which price tags are not easily assigned. These values are often called functional values, because they serve a function to society as a whole, but may not be immediately realized or marketable to wetland owners. Wetlands in North Dakota can be valuable for improving water quality, providing natural flood control and recharging groundwater aquifers.

WATER QUALITY

Wetlands slow the flow of water run-off from agricultural land, allowing suspended sediments to settle out before they flow into nearby lakes or rivers. Retaining sediments on the land is useful for both the landowner and for people who live downstream. These sediments also may hold nutrients and chemicals that are deposited into the wetland basin. Wetland plants can absorb these nutrients and chemicals and fix them into organic matter that is stored in the soil for later use. Excessive amounts of nutrients that are not stopped from running into rivers and lakes reduce water quality and can cause problems, such as algae blooms.

Wetland vegetation also has the ability to remove heavy metals, pesticides, and other toxins from water. Through complex ecological processes, these wetlands can prevent contaminants from entering ground or surface water.

NATURAL FLOOD CONTROL

Wetlands can provide natural flood control by storing spring run-off or high summer rainfalls. Water held in wetland basins will be slowly released over the surface, into the groundwater, or will slowly evaporate into the air. While this may not be an immediate benefit to a wetland owner, it will mean a reduction in downstream flood water. The slow release of water can also mean less damage to downstream culverts, roads and bridges.

GROUNDWATER RECHARGE AND DISCHARGE

The hydrology of the prairie pothole country is complex. Depending on the type and location of a wetland, it will either recharge groundwater, or act as a groundwater discharge point. Discharge points, such as artesian wells, often have a direct benefit by providing water sources for home or agricultural purposes. The benefit of wetlands that discharge into the groundwater is indirect and hard to visualize because aquifers cannot be seen. Seasonal, temporary and permanent wetlands can contribute to aquifer recharge, which in turn provides water management capabilities for irrigation and water supply.

WETLAND VALUES

A person's perspective of something will establish its value, merit or worth. To one person, a rare or unique item will have high value. To another person, this rare item will have little or no value because it may serve no useful purpose.

In the example of wetlands, a conservationist who determines that a wetland is "unique" will consider that wetland irreplaceable, whereas the landowner, who gains no economic value from it, will consider the area a "nuisance." Clearly in this case, the term "value" means completely different things to these two people.

A landowner will have a different perspective of a wetland than a city-dwelling duck hunter. The owner of a local sporting goods store will value a wetland differently than a school teacher who uses a wetland as an outdoor classroom. Whatever the perspective, many people feel that wetlands are valuable for one reason or another. This section will highlight some of these values and perspectives.

ECONOMIC VALUES

Landowners who farm or ranch their land most often value a wetland by its capacity for financial gain or loss.

For several years, efforts have been made to put a price on wetlands, but valuation is difficult for several reasons. According to wetland scientists William Mitsch and James Gosselink:

(1) Wetlands are valuable for many different reasons. The person evaluating a wetland must compare and weigh different uses. For example, a freshwater area is more valuable for waterfowl than a salt marsh area, but the salt marsh is more valuable as a fish habitat. Which wetland receives a higher value depends on the evaluator and his or her personal judgement.

(2) The most valuable aspects of wetlands are their public uses which have little or no commercial value to the private land owner. The land owner cannot place a value on the ability of his marsh to purify wastewater or buffer a tidal surge of water. The owner does not benefit from the harvest of marsh-dependent fish. There is a natural conflict between the owner's conception of his or her best interests and the interests of the public.

(3) There is an inverse ratio to the value of wetlands. As the amount of wetlands decreases, the value of the remaining wetlands increases. The ecological value of wetlands is dependent upon its place in the total geographic landscape; a wetland may have little value on its own but may be invaluable based upon the role it plays within the regional landscape.

Although it may be difficult to define a specific price, the economic value of wetlands can be identified in some cases. For example, the recreational fishery of the Devils Lake basin produced direct economic returns for that region: Devils Lake fishermen spent $12 million during the 1983-1984 fishing season. Outside of North Dakota, tidal salt marshes are

among the most productive ecosystems of the world. The productivity of these marshes support the commercial seafood industry. About two-thirds of the fish and shellfish harvested commercially are dependent on wetlands.

Waterfowl sport hunting is dependent on the existence of healthy wetland habitats. In 1990, resident waterfowl hunters spent $17.2 million in North Dakota in pursuit of their sport. Other animals harvested for sport and commercial purposes are tied to wetlands. The trapping industry, for example, produces $35 million annually in beaver, mink, muskrat, and other pelts, on a national basis.

OUTDOOR RECREATION

Many outdoor recreation activities in North Dakota are tied either directly or indirectly to wetlands. Hunting and fishing are well known and provide economic returns to local economies and contribute to tourism, North Dakota's third largest industry. North Dakotans participate in activities such as bird watching, wildlife viewing, photography and canoeing on or near wetlands. A survey conducted in 1991 demonstrated that over 42 percent of North Dakota residents participated in non-consumptive wildlife activities, such as wildlife feeding, photography, and wildlife watching.

EDUCATION AND RESEARCH

Educational and research values of wetlands are considered idealistic to some, but essential to others. Educators and students reap immeasurable benefits from learning about ecology and wildlife in wetland outdoor classrooms. Scientists need natural systems to compare against treated systems when they conduct studies that benefit people, and wetlands can provide this natural system. The value of research to improve human conditions is often impossible to measure, since the benefits are long-term and far-reaching.

Introductory Activities

Activities in this section will introduce students to terms associated with wetlands. Students will express beliefs and attitudes about wetlands, and they will also learn why wetlands occur in North Dakota.

WETLAND TERMINOLOGY

ABSTRACT

SUMMARY:
Students will learn wetland terms through the use of a word search and classroom discussion.

AGES: Grades 4 to 8

SUBJECT: North Dakota Studies, Science, Social Studies, Geography, and Language Arts

DURATION: 20 to 30 minutes

GROUP SIZE: whole class, as individuals or in pairs

SETTING: indoors

SKILLS: Communication, Discussion, Identification, Reading, Spelling, Visualization, Writing

NORTH DAKOTA CURRICULUM REFERENCE:
LANG (K-4) 1a,b,d,g; 2f
LANG (5-8) 2b;
SOC (K-4) 11a,d; SOC (5-8) 11a;

INTENDED LEARNING OUTCOMES

Students will learn terms and definitions associated with wetlands.

RATIONALE

Learning about wetland associated terms will build a foundation for understanding and appreciating North Dakota wetlands.

STUDENT PRIOR KNOWLEDGE

Students should understand the term wetland.

BACKGROUND

Wetlands are dynamic ecosystems. They are a transition stage between dry uplands and deepwater ecosystems. There are many terms that are used to describe wetlands. The term "wetland" is a self descriptive word, "wet land." Some terms are used statewide and some terms are local dialects for the word wetland. However, some terms have slightly different meanings depending upon where the "wet land" is found in the United States. In North Dakota, wetlands are not only found in isolated depressions, but are also associated with shallow bays of lakes, and flood plains of rivers. In the Turtle Mountains and Pembina Hills regions of the state, bogs and fens are old lake beds and are in a particular stage of a lengthy successional process.

This activity will help students learn about different terms for wetlands, and help them learn about what kinds of wetlands are found in North Dakota.

KEY VOCABULARY: bog, depression, fen, glacier, groundwater, hydric soil, hydrophytic, lake, marsh, permanent wetland, pond, pothole, precipitation, puddle, riparian, run-off, saline wetland, scars, seasonal wetland, semipermanent wetland, shallow, slough, swamp, temporary wetland, waterfowl, wetland

MATERIALS

1. Pencils
2. Student Page (See Photocopy Booklet)
3. Teacher's edition word search for vocabulary list, answers, and mystery sentence answer.
4. Blackboard or overhead

PROCEDURE

1. Write the word search vocabulary list on the board or overhead.
2. Pronounce wetland terms, and have students repeat terms.
3. Class Discussion about terms.
   Question: What characteristic do all terms share? (How are they related? They all have water, are found in a shallow or deep depressions, and water does not permeate the soil.)
   Student response: Allow for any related characteristic but direct answers to WATER and DEPRESSIONS.
   Example Student Response: "Wildlife" - Teacher Response - "If wildlife is present,what else must be there? Etc.
4. Discussion: Leading to water and depressions are the common tie.
5. Have the students write and share definitions of a wetland and wetland types.
6. Define a wetland.
7. Hand out word search student page.
8. Have the students locate words on the student page from the word set on the blackboard.
9. Allow time to complete the student page.
10. Closure: Wetland is an area that has water-logged soil, water-loving plants, and has water for varying lengths of time and may not have water during drought years.

EXTENSIONS

1. Have students read relevant magazine articles about North Dakota wetlands. (e.g., National Geographic, North Dakota Water, Junior Scholastic, Discover, North Dakota Outdoors, North Dakota REC/RTC, Local Newspaper Articles). See if they can find new terms or add new ones to the list.

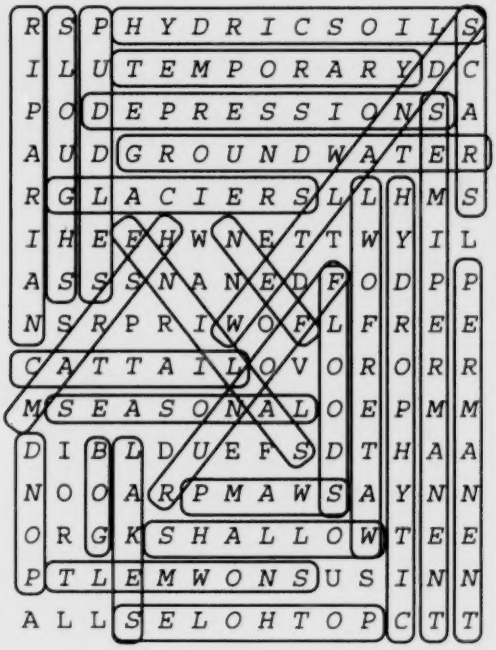
EVALUATION

1. Have each student write his or her definition of a wetland.
2. Have each student search for magazine or newspaper articles that use the terms found in the word search.
3. Word search evaluation.

TEACHER'S EDITION

North Dakota Wetlands Word Search Answers

Words appear UP, DOWN, BACKWARDS, and DIAGONALLY. Find and circle each word. Use the remaining letters to solve the mystery sentence below.


R S P H Y D R I C S O I L S
I L U T E M P O R A R Y D C
P O D E P R E S S I O N S A
A U D G R O U N D W A T E R
R G L A C I E R S L L H M S
I H E E H W N E T T W Y I L
A S S S N A N E D F O D P P
N S R P R I W O F L F R E E
C A T T A I L O V O R O R R
M S E A S O N A L O E P M M
D I B L D U E F S D T H A A
N O O A R P M A W S A Y N N
O R G K S H A L L O W T E E
P T L E M W O N S U S I N N
A L L S E L O H T O P C T T

* Glaciers
* Potholes
* Wetlands
* Hydric Soils
* Shallow
* Saline
* Temporary
* Permanent
* Floods
* Marsh
* Scars
* Pond
* Sloughs
* Run-off
* Puddles
* Cattail
* Seasonal
* Bog
* Swamp
* Depressions
* Lakes
* Waterfowl
* Hydrophytic
* Groundwater
* Snow melt
* Semipermanent
* Fen
* Riparian

W E T L A N D S P R O V I D E F O R U S A L L !

WITTY WORDS ON WETLANDS

ABSTRACT

SUMMARY:
Students will be able to express their beliefs and attitudes about wetlands and put them in an expressive language form.

AGES: Grades 5 to 9

SUBJECT: Language Arts, Science, and Social Studies

DURATION: 50 to 80 minutes

GROUP SIZE: whole class

SETTING: indoors or outdoors

SKILLS: Description, Library Reading, Skills, Writing

NORTH DAKOTA CURRICULUM REFERENCE:
LANG (5-8) 1a,b,c,e,f,h,j; 2a,b,e; 3b,c; LANG (9-12) 1c,e,h; 2a,f; 3a,c
SCI (5-8) 2d,g; SCI (9-12) 2d,f
SOC (5-8) 11a
SOC (9-12) 11a,b

KEY VOCABULARY: key terms in the story, article or book

INTENDED LEARNING OUTCOMES

Students will learn about vocabulary associated with wetlands, about wetlands, and how to express their beliefs and attitudes in verse.

RATIONALE

To provide students an opportunity to express their attitudes and appreciation or awareness of wetlands using language arts.

STUDENT PRIOR KNOWLEDGE

Students should know English and general information on wetlands, and how to organize their thoughts and express themselves.

BACKGROUND

Wetlands or prairie potholes are commonly found on North Dakota's landscape. Our state's wetlands are one of the most productive of all systems on earth in terms of capturing and converting sunlight to stored energy. Each wetland is a complex community of living organisms interacting with its physical environment.

This activity provides students an opportunity to learn about their state's natural resources.

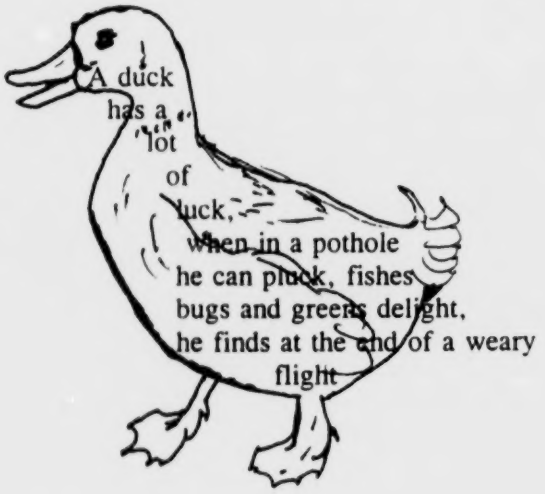
MATERIALS

1. Paper
2. Pens/pencil
3. Crayons
4. Wetland photographs, read a story about wetlands, or visit a wetland.

PROCEDURE

1. As inspiration, have the students visit a wetland, read a story about wetlands, discuss photographs of wetlands, or assign the students to find a magazine article or book about wetlands or wetland animals.
2. Ask the students to write a poem about wetlands or a wetland animal.
3. For the elementary teachers, students may enjoy writing the poem in the shape of what they are writing about.

   See the following example:



EXTENSIONS

1. Cinquain (sing'kan') - This word is derived from French and Latin words for five. Cinquain poems consist of five lines, and each line has a mandatory purpose and number of syllables: (1) the title in two syllables, (2) a description of the title is four syllables, (3) a description of action in six syllables, (4) a description of a feeling in eight syllables, and (5) another word for the title in two syllables. *(Reprinted with permission, American Forest Foundation, ©1993, Project Learning Tree Environmental Education Activity Guide Pre K-8. The complete Activity Guide can be obtained by attending a PLT workshop. For more information call the National PLT office at 202/463-2462.)*

Wetlands
teaming, steaming
filled with plants and frogs
holding, storing, cleaning, growing
Water

2. Have the students generate a list of words, phrases, or puns that have been influenced by water and incorporated to our vocabulary and language. For example: "Up the Creek without a paddle," "You're a drip," "You're all wet," and "We were swamped with activities!"

EVALUATION

1. Have the students write a poem in several styles.

SUGGESTED READING

Iowa State University Extension. May 1991. Wetlands, Wildlife, and You!, Ames, Iowa 50011, Pm-1425, Grades 4 to 8. (See WET Reference binder)

Environmental Protection Agency, Welcome to Wetlands, Wetlands Coordinator, Water Division, 230 S. Dearborn St., Chicago, IL 60604

Western Hemisphere Shorebird Reserve Network, Animal Superheros?, Wetlands for Americas, P.O. Box 1770, Manomet, MA 02345. (See WET Reference binder)

PUTTING ON THE MAP

ABSTRACT

SUMMARY:
Through the use of maps, students will learn why wetlands exist, where they exist and their relationship to water bird habitat.

AGES: Grades 4 to 8

SUBJECT: North Dakota Studies, Science, Social Studies, Geography

DURATION: 25 to 50 minutes

GROUP SIZE: whole class, as individuals or in pairs

SETTING: indoors

SKILLS: Application, Communication, Discussion, Drawing, Listening, Mapping

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a; 2a,c; 3a,e; 4b
SCI (5-8) 1a; 2a,c,d,g; 3b,f; 4a; 5d
SOC (K-4) 11a,b,d; 13a
SOC (5-8) 11a; 13a

INTENDED LEARNING OUTCOMES

The student will learn how geography and geological processes influence the location of wetlands.

RATIONALE

The living environment is the product of the landscape. This activity uses maps to illustrate how the North Dakota landscape is associated with the occurrence of wetland habitats.

STUDENT PRIOR KNOWLEDGE

Students should know what constitutes a wetland. Students should know that glaciers once covered North Dakota, and helped form various land features.

BACKGROUND

North Dakota has a bounty of natural resources. Some of these resources include coal and oil deposits, productive agricultural soils, wetlands and wildlife habitat. All of the resources found in our state are a product of geologic and natural processes that occurred long ago. A large part of the face of North Dakota was formed more than 10,000 years ago, yet what happened long ago still influences our state today and will in the future.

Glaciers played a vital role in forming the land features that we find today in North Dakota. The Missouri coteau slope is an area east of the Missouri River that has both erosional and glacial landforms. The Missouri coteau is a dead-ice moraine where glacier deposits are thick, and large-scale glacial stagnation processes predominated resulting in a hilly, irregular surface. The glaciated plains is an area of relatively thick glacial sediments where large-scale glacier thrusting coupled with deposition due to melting of the glacier, resulted in an intricate landscape of more gentle relief than the Missouri

KEY VOCABULARY: dead-ice moraine, glaciated plains (drift plain), habitat, Missouri coteau, Missouri coteau slope, physiographic

coteau. The Red River Valley is an exceptionally flat plain that was the former floor of glacial Lake Agassiz.

The distribution of wetlands correlates with the distribution of various glacial landforms. The wetlands in the Missouri coteau are somewhat larger and deeper, and contain surface water more permanent that those wetlands on the glaciated plains. Therefore, the largest number of semipermanent wetlands are found in the Missouri coteau. However, the largest area and number of wetlands is found in the glaciated plains. There are also a larger number of temporary and seasonal wetlands found in the glaciated plains. Because of its flat relief fewer wetlands are found in the Red River Valley region.

Because waterfowl depend exclusively upon wetlands during migration and the breeding and brood rearing season, the distribution of waterfowl habitat correlates with the distribution of wetlands.

MATERIALS

1. North Dakota highway map and 3 individual maps (Maps 1-3, see Photocopy Booklet)
2. Paper
3. Pencils/markers/colored pencils
4. Sheets of acetate
5. Student Page map (See Photocopy Booklet), one for each student

PROCEDURE

1. Review what is a wetland and how North Dakota's landscape was influenced by glacial activity.
2. Using a North Dakota highway map, students should locate major geographic features such as rivers, lakes, and cities.
3. Question: Are these wetlands?

   Answer: No, because in the rivers the water is moving, and the lakes are deepwater environments, with water depths of 6 feet or greater.

4. Observe the highway map more closely.
   - Are there more lakes in one part of the state than in another? Yes!
   - Where? Generally north and east of the Missouri River.
   - Why? Because of glacial activity and its influence on North Dakota's landscape.
5. Hand out to students a copy of the student page.
6. Place map 1, the general outline map, on overhead.
7. Hand out blank sheet of acetate.
8. Teacher overlay map 2 (physiographic region map) over map 1 (general outline map).
9. Discuss the effect of glacial movement on North Dakota's geography.
10. Students will mark boundaries of physiographic regions and label on their map, with colored pencils or markers. Refer back to North Dakota highway map, ask for a volunteer to point out physiographic regions on highway map.
11. Remove physiographic map from overhead.
12. Place map 3 (wetland habitat map) on the overhead. Establish connection between wetland habitat location and the impact of glacial activity on North Dakota's landscape.
13. On the piece of acetate, have the students draw roughly the areas with excellent to poor waterfowl habitat.
14. Why are more wetlands found north and east of the Missouri River?
15. Return physiographic overlay map to the overhead.
16. Conclude with a class discussion on wetland location and how it is influenced by geologic processes. Wetlands provide habitat for waterfowl and shorebirds. For older students, discuss what type of glacial movement formed the Missouri Coteau and Glaciated Plains and how their landforms differ.

EXTENSIONS

1. "Migration Headache" (This activity can be found in the "Wetland Community" section of the *Guide*.)
2. Have the students work on their geography skills by learning more about some significant wetland areas in North Dakota.

3. Using a 1:24,000 scale topography map from your area estimate the number of wetland acres on the map, and calculate the percentage of wetland area relative to land area. (Maps can be ordered for $2.50 each from: North Dakota Geological Survey, 1022 E. Divide, Bismarck, ND 58501; phone number 224-4109.)

EVALUATION

1. Student map work.
2. Classroom discussion.
3. Have the students prepare a written summary of the relationship between the outline map of North Dakota, physiographic map, and the wetland habitat map.

REFERENCES

Bluemle, John P. 1991. The Face of North Dakota, Revised Edition. North Dakota Geological Survey, Educational Series 21. 177 pages.

Kantrud, H.A., G.L. Krapu, and G.A. Swanson. 1989. Prairie basin wetlands of the Dakotas: a community profile. U.S. Fish and Wildlife Service, Biological Report 85(7.28). 116 pages.

SUGGESTED VIEWING

Video - "Landforms of North Dakota" This video can be obtained by writing:

North Dakota Geological Survey
1022 East Divide
Bismarck, ND 58501
phone # (701) 328-4109

IT'S DOWNHILL FROM HERE

ABSTRACT

SUMMARY:
Through various demonstrations students will learn the relationship between topography, soil and wetland location.

AGES: Grades 4 to 8 - Younger or older depending upon how much detail you wish to cover.

SUBJECT:
North Dakota Studies, Earth Science, Social Studies, Geography

DURATION: Part A: 15 to 20 minutes, Part B: 50 minutes; Total of 15 to 70 minutes

GROUP SIZE: whole class, as individuals or in small groups

SETTING: indoors

SKILLS: Cooperative Learning, Description, Discussion, Generalizations, Observation, Prediction, Reporting, Writing

INTENDED LEARNING OUTCOMES

Students will learn the connection between topography, soils and the location of a wetland.

RATIONALE

There are many factors that influence the location of wetlands. Two of these factors are topography and soil. Through the following activity, students will develop a better understanding of the relationship of topography, soil and wetlands.

STUDENT PRIOR KNOWLEDGE

Students should know what a wetland is, and have knowledge of topography and topography maps.

BACKGROUND

A wetland basin is a depression capable of holding surface water. Prairie wetlands occur in glacial- or postglacial-derived basins. Shallow basins were left by the scouring and shearing action of the glaciers or from the collapse of melting ice blocks left behind by the retreating glaciers. Along with the wetland basins, the glaciers left landforms of undulating and rolling uplands. (See "Ice in Motion" and "Putting on the Map" for additional background information.) In the rolling landscape, wetlands are found in the low spots.

In North Dakota, wetland basins are filled primarily by melting water and early spring rains, and some wetlands have groundwater sources. Wetland water sources from precipitation come from the wetland watershed. The precipitation that falls on the upland portions of the watershed run-off to the lowest elevation, which is generally where wetlands are located.

NORTH CURRICULUM REFERENCE:
SCI (K-4) 1a; 2a,c; 3a,e; 5a
SCI (5-8) 1a; 2a,g; 3a,f; 4c; 5d
SOC (K-4) 11a,b,d; 13a
SOC (5-8) 11a; 13a

KEY VOCABULARY:
depression, glacier, pooling, run-off, watershed, wetland
Optional: elevation, topography, landform

MATERIALS

Part A:

1. Paper towels
2. Container filled with tap water
3. Cafeteria or paper napkin
4. Chalkboard or overhead projector with pen
5. Tub or bucket

Part B:

1. Rectangular pan (9" x 13")
2. Play dough (do not use blue or white)
3. Water
4. Spray bottles (one for each model)
5. Containers for water
6. Paper towels
7. Chalkboard or overhead projector

PROCEDURE

Part A:

1. Ask for three volunteers to come forward.
   a. One student should hold his or her hand as flat or level as possible.
   b. Another student should cup his or her hand slightly.
   c. The third student should cup both of his or her hands together.
2. Have the students predict what will happen to water poured into each of the volunteers' hands. Write the predictions on the chalkboard or overhead projector.
3. One at a time, proceed to pour water in each of the volunteer students' hands. Have each student keep as much water as possible in his or her hands while you go to the next student.
4. Have the volunteers describe what happened to the water when it was poured into their hands.
5. Check student predictions against their observations.
6. Select three new volunteers.
7. Place a cafeteria napkin in each volunteers' hand/s. The volunteers should hold their hands the same as previous volunteers during steps 1a-c.

8. Have the students predict what will happen with the water now that the napkin is placed in the students' hand/s. Write the predictions on the chalkboard or overhead projector.
9. One at a time, proceed again to pour water in each of the volunteer student's hands.
10. Check and discuss predictions against observations.
11. Discuss with the class what the hands (topography) and napkins (wetland soil) represent in this demonstration.
12. Concluding remarks and discussion:

    Make certain students grasp the concept that a wetland is more than just a depression in the ground that it is the result of water collecting in low spots (depressions) and that water is held by the soil.

Part B: (day two)

Introduction: Review concept of depressions and wetlands

1. Create a playdough teacher's model showing different slopes and wetland basin depths.
2. Teacher Model: Using a pan and playdough create a mock landscape with varied elevations. Elevations should include: high at one end of pan, depressions - some shallower than others and varying in size, and create some waterways.
3. Have students predict what will happen when water is poured (run-off) or sprayed (simulated rainfall) onto this landscape.
4. Write student prediction on overhead or chalkboard.
5. Ask individual students to come forward and place toothpicks where they think the water will collect.
6. Proceed with demonstration. Spray water to simulate rain then observe and discuss. Now pour to simulate run-off then observe and discuss.
7. Compare results with prediction.

EXTENSIONS

1. Have students identify potential types of wetlands found in teachers' or their models. Follow-up with a discussion of temporary, seasonal, semipermanent, and permanent wetland types. See Teacher Background information for a discussion of these wetland types.

2. May divide class into groups of 3 if you wish,
   a. Distribute pans and play dough
   b. Students, following teacher example, will design their mock wetland landscape - allow 10 minutes.
3. For older students, have them mark each wetland's watershed in the teacher's model or their own models.
4. For older students, have them examine 1:24,000 scale topographic maps from your area. Students should mark on the map where wetlands are found. Students should also mark the wetland's watershed, based on surrounding land elevations. (Maps can be ordered for $2.50 each from: North Dakota Geological Survey, 1022 East Divide, Bismarck, ND 58501; phone number 328-4109.) Or, obtain a local copy of National Wetland Inventory maps from your local U.S. Fish and Wildlife Service Wetland Management District office. See the "Agencies and Organizations associated with Wetlands Conservation" section for a list of Wetland Management District offices.

EVALUATION

1. Have students write down predictions and compare.
2. Have students create their own play dough models with toothpicks marking wetland areas.
3. Have the students prepare a written description of the model and result of rainfall and run-off experiment.
4. Student participation in discussion
5. Have students draw a topographic map of the wetland model.

ICE IN MOTION!!

ABSTRACT

SUMMARY:
Students will learn how North Dakota wetland basins were formed by glaciers.

AGES: Grades 4 to 10

SUBJECT: Earth Science, Math, Geology, Social Studies

DURATION: 25 to 35 minutes

GROUP SIZE: whole class, as individuals or in pairs

SETTING: indoors or outdoors

SKILLS: Computation, Description, Estimating, Experimenting, Extrapolation, Mapping, Observation, Prediction, Writing

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a; 2a,c; 3b,e
SCI (5-8) 1a; 2a,b; 3b,f; 4a
SCI (9-12) 2a,d; 3a,h; 4c
MATH (K-4) 4a; 8c
MATH (5-8) 8a,b
MATH (9-12) 8a,b
SOC (K-4) 11a
SOC (5-8) 11a; 13a
SOC (9-12) 11a; 13a

INTENDED LEARNING OUTCOMES

The student will predict and learn how wetland depressions were formed. The student will learn about glacial processes and geologic history of North Dakota. The student will learn about how glaciers created North Dakota landforms, and how they influence today's land uses.

RATIONALE

The subject of North Dakota's geologic history is critical in understanding and appreciating why wetlands occur in our state, and why there are so many. Different people have different images of glacial processes and how those processes affect the state's landscape.

STUDENT PRIOR KNOWLEDGE

Student should know that geological processes determine landforms.

BACKGROUND

It is hard to believe that today's North Dakota landscape, the location of its rivers and direction of the rivers' flow is due to glaciation. This major geological process is the result of huge sheets of ice flowing only by inches or feet daily. These sheets of ice are what carved much of the modern North Dakota landscape.

The last major southward expansion of ice, the Late Wisconsinan glaciation, began about 26,000 years ago. It eventually buried all of eastern and northern North Dakota beneath several thousand feet of ice. About 16,000 years ago, the climate began to moderate, but it took 3,000 years before the ice melted back far enough to re-expose large parts of land in North Dakota. The Wisconsinan Glaciation ended about

KEY VOCABULARY: basin, depression, geology, glacier, ice age, landform, wetland

10,000 years ago after having buried all but the southwestern corner of North Dakota under ice for 15,000 years.

Glacial ice remained on the Turtle Mountains and over much of the Missouri Coteau until 9,000 years ago. Ice in these areas was insulated by a layer of glacial sediment. This ice took several thousand years to melt and collapse. When the overlying material slumped and slid, thousands of basins of all shapes and sizes formed. These basins formed "prairie potholes." Many more such depressions were formed when buried, or partially buried blocks of stagnant glacial ice melted and caused overlying materials to slump down, forming depressions called kettles. These depressions formed the basins for wetlands in the state.

MATERIALS

1. Container with a minimum dimensions of 5" X 4" (e.g., coffee can, plastic containers, aluminum loaf pan)
2. Sand, preferably damp
3. Ice cubes or chunk of ice; freezer
4. Hair dryer (winter) or warm day (summer)
5. Paper towels to clean hands

PROCEDURE

1. Briefly discuss wetlands in North Dakota. The students may have this foundation.
2. Ask the students how North Dakota's surface lands have changed during the past 30,000 years. Glaciers may come up in the discussion. Have the students predict how wetland basins were formed in North Dakota.
3. The activity will help students understand how wetlands were formed. Students can be placed into groups of two or three individuals. Have the students take the container and place about 2 inches of sand on the bottom. Now, have the students take several ice cubes and bury them into the surface of the sand. Next, cover the ice cubes with sand and pack the sand around the cubes. Now, wait for the ice cubes to melt. The melting can be quicken by using a hair dryer, or with the help of the sun.

4. This activity could be started, and then gone back to after the ice melts.
5. You will see that after the ice has melted, a depression will form which is how a majority of wetland basins were formed by glacial activity.

EXTENSIONS

1. Prior to placing the ice cube or chunk of ice into the sand, students could be assigned to weigh and measure the size of the ice cube.
2. After the depression is formed, the students could be asked to measure the volume of the depression formed. Then, the students could measure the volume of a natural wetland basin. The student can extrapolate the weight and size of the ice chunk that formed the natural wetland basin based on the relative proportion of the ice cube and depression that was formed during the experiment.
3. The student could also use different soil types for the experiment. The students could predict if the depression formed in different soil types will be different, and if so how they will be different.
4. The ice cubes could be buried in different topography features. The student could predict how the topographic feature affects the depression formed.
5. Students could experiment with how different rates of melting affect the depression formed by the ice cube.
6. Students could make a cross-section topography map of their formations.

EVALUATION

1. Have the student describe in writing the formation of wetland basins.
2. Have the student describe landforms near their home, and have them predict how they were formed.
3. Have the students draw a North Dakota area before and after glaciation.
4. Have the students describe the activity in their own words for parents or other kids.

SUGGESTED READING

Bluemle, J. P., 1975. Guide to the geology of northwest North Dakota. North Dakota Geological Survey Educational Series 8, 38 pages.

Bluemle, J.P., 1975. Guide to the geology of southwest North Dakota. North Dakota Geological Survey Educational Series 9, 37 pages.

Bluemle, J.P., 1988. Guide to the geology of southeastern North Dakota. North Dakota Geological Survey Educational Series 18, 36 pages.

Bluemle, J.P., 1988. Guide to the geology of north-central North Dakota. North Dakota Geological Survey Educational Series 19, 42 pages.

Bluemle, J.P., 1988. Guide to the geology of south-central North Dakota. North Dakota Geological Educational Series 20, 44 pages.

Bluemle, M.E., 1988. Guide to geology of northeastern North Dakota. North Dakota Geological Educational Series 17, 32 pages.

Bluemle, M.E., Face of North Dakota. Educational Series 21, 177 pages.

Kantrud, H.A., G.A. Krapu, and G.A. Swanson. 1989. Prairie Basin Wetlands of the Dakotas: A Community Profile. U.S. Dept. of Interior, Biological Report 85(7.28), 111 pages.

WETLAND FUNCTIONS

WETLAND METAPHORS

(Adapted with permission from Project WILD, © 1987, 1992 Western Regional Environmental Education Council)

ABSTRACT

SUMMARY:
Students are presented with a selection of "hands-on" objects for investigation as metaphors for natural functions of wetlands.

AGES: Grades 1 to 12

SUBJECT: Science and Language Arts

DURATION: 60 to 120 minutes

GROUP SIZE: whole class, individually or in small groups of 3 to 4 students

SETTING: indoors or outdoors

SKILLS: Analysis, Application, Classification, Comparing similarities and differences, Description, Generalization, Identification, Inference, Interpretation, Listing, Public speaking, Recognition, Reporting, Small group work, Synthesis, Visualization

INTENDED LEARNING OUTCOMES

Students will learn to describe the characteristics of wetlands, and demonstrate their understanding of the importance of wetlands to wildlife and humans.

RATIONALE

To understand why wetlands are important to the environment and humans, students should understand the functions that wetlands perform.

STUDENT PRIOR KNOWLEDGE

Students should be able to mentally picture a wetland.

BACKGROUND

Wetlands are many different things to many different people. Some people have never heard or thought about wetlands. Others are working actively to protect wetlands because of their importance. Wetlands are uniquely important to plants, animals, humans, and the total environment.

Because of the abundance of food, vegetative cover (shelter), and water found there, most wetlands are rich with diverse wildlife species. North Dakota's wetlands, for example, provide nesting, breeding and resting habitat for thousands of migratory birds--including ducks, geese, swans, cranes, and shore birds. Many species of fish that are important for commercial and personal use by humans reproduce and spend part, or all, or their life cycle in fertile wetlands. These fish species include bass, walleye, perch, northern pike, and fathead minnows. A wide variety of reptiles, amphibians, insects, and crustaceans also breed and live in wetlands. Frogs, toads, turtles, salamanders, snakes, dragonflies, water striders, clams,

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a; 2a,c; 3e; 4b,c; 5a,b
SCI (5-8) 1a,b; 2a,g; 3f; 4a,b; 5c,e
SCI (9-12) 1a,c; 2d,f; 3a,d; 4a,d; 5e
LANG (K-4) 1d,g; 2f; 4a
LANG (5-8) 1c,h; 2a,b,e; 4e,g,j
LANG (9-12) 1c,e,h; 2a,f; 4a

KEY VOCABULARY: metaphor, wetland

and crayfish flourish in wetland habitats. Many mammals--from muskrats and beaver to white-tailed deer and moose--also depend on wetland areas.

Wetlands are often referred to as "nurseries" because they provide critical breeding and rearing habitats for countless numbers and kinds of wildlife. Wetlands also have the unique ability to purify the environment. They act as natural filtering systems and have been shown to be extremely effective; for example, they can trap and neutralize sewage waste, allow silt to settle, and promote the decomposition of many toxic substances.

The importance of vegetation associated with wetlands cannot be overlooked. Plants absorb nutrients and help cycle them through food webs. Plants also help keep nutrient concentrations from reaching toxic levels. Plants slow down water flow causing silt to settle out. Through photosynthesis, plants add oxygen to the system and provide food to other life forms. Of great importance to humans are the flood control characteristics of wetlands. When run-off from rains and spring thaws is high, wetland areas absorb excess water until it gradually drains away down streams and rivers and through the soil. Acting as buffers, healthy wetlands prevent flooding and erosion. In dryer periods, wetlands hold precious moisture after open bodies of water have disappeared. The many activities that take place in wetlands make them among the most productive ecosystems in the world.

As remarkable and resilient as wetlands are, these unique areas have limits. Their destruction and/or abuse can have devastating effects on wildlife, humans, and overall environmental quality.

Many of the major attributes of wetlands can be explored through the use of metaphors. To use a metaphor is to apply a word or phrase to an object or concept which it does not literally denote, in order to suggest a comparison between the two. A metaphor represents a concept or idea through another concept or idea. "A tree is a home" and "Books are windows of thought" are two examples. In this activity a variety of everyday objects are used to represent the natural functions of wetlands. The major purpose of this activity is for students to develop an appreciation and understanding of wetlands through the power of metaphor, linking the characteristics and natural

functions of wetlands to the familiar realm of everyday life.

For example:

OBJECT	METAPHORIC FUNCTION
sponge	absorbs excess water caused by run-off; retains moisture for a time even if standing water dries up (e.g., sponge placed in a small puddle of water absorbs water until saturated, then stays wet after standing water has evaporated)
pillow or bed	is a resting place for migratory birds
mixer or egg beater	mixes nutrients and oxygen into the water
cradle	provides a nursery that shelters, protects, and feeds young wildlife
sieve or strainer	strains silt, debris, etc., from water
filter	filters smaller impurities from water
antacid	neutralizes toxic substances
cereal	provides nutrient-rich foods
soap	helps cleanse the environment, as wetlands do

MATERIALS

1. Large pillowcase, bag, or box
2. Sponge
3. Small pillow
4. Soap
5. Eggbeater or mixer
6. Small doll cradle
7. Sieve or strainer
8. Paper (coffee) filter
9. Antacid tablets
10. Small box of cereal

11. 3 X 5 cards with pictures that could be used to show other wetland metaphors (a zoo could represent the idea of wildlife diversity in a wetland, a lush vegetable garden could represent the idea of a productive wetland in which food is abundant, a vacation resort could represent the idea of a resting or wintering place for migrating waterfowl).

Note: A metaphoric approach such as this allows a variety of objects to suggest some appropriate linkage to the basic characteristics of wetlands.

PROCEDURE

1. Prepare a "Mystery Metaphor Container" (pillowcase, bag or box). It should be possible for students to put their hand into the container and pull out an object. You may want to collect as many as one metaphoric object per student, but at least have enough for one per group of four students. Put the container aside to use later.
2. Discuss the variety of wetlands found in your local area and state. Then invite the students to sit quietly and close their eyes. Ask them to imagine and visualize a wetland. Have them examine what it looks like. Have them look carefully at the plants and animals, including insects and small creatures. What does the air feel like? How does it smell? Optional: Play a tape recording of natural sounds from wetlands. Some are available commercially in record and nature stores.
3. Invite the students to tell what they imagined. Compile a list of their offerings. Encourage discussion and mutual sharing.
4. With their list as a point of reference, help the students identify which plants and animals are actually most likely to be found in a wetland.
5. Next provide the students with background information to serve as an overview of the basic ecological activities that characterize the wetland habitat. For example, you can include the following:
   - Sponge effect - absorbs run-off
   - Filter effect - takes out silt, toxins, wastes, etc.

- Nutrient control - absorbs nutrients from fertilizers and other sources that may cause contamination downstream
- Natural nursery - provides protection and nourishment for newborn wildlife

Suggest that these activities and many more that they could probably think of are taking place in wetlands all the time.

6. Now bring out the "Mystery Metaphor Container." Tell students that everything in the container has something to do with a wetland. Have the students divide into groups of four. Announce that when it is their turn, you want a representative of each group to draw an object from the container. Then, as a group, they must figure out how the object could represent what a wetland is or does.
7. Have the designated student reach into the container and withdraw one object. When each group has an object, ask them to work as a team to describe the relationships between their metaphoric object and the wetland. Encourage the students to build on each other's ideas. You can also assist by strengthening their connections. **Note:** Allow the students time to discuss their ideas with each other before doing so in front of the entire class.
8. Ask each group to report their ideas to the class.
9. Following discussion and review of the functions represented by each metaphor, ask the students to summarize the major roles that wetlands perform in contributing to habitat for wildlife. List the ways in which wetlands are important to other uses? Ask them if their own attitudes about wetlands are different now. If yes, how? If not, why not?
10. For the final part of this activity, encourage the students' understanding of how the wetlands' condition depends upon each of us. Many kinds of wildlife depend upon wetlands. Our own well-being requires wetland ecosystems. Strengthen the students' understanding of the connections that humans have to wetlands. Recreation, aesthetics, utilitarian uses, environmental quality, and nature study are but a few of the connections we each have with wetlands.

EXTENSIONS

1. Visit a wetland to verify the appropriateness of the metaphors explored in the classroom. Identify and discuss any limitations to the appropriateness of these metaphors. Identify what seem to be the most compelling attributes of the metaphors in helping you understand the characteristics and nature of the wetland. Expand on your understanding of these metaphors. Identify new and appropriate metaphors!
2. Investigate local, county, state, and federal regulations and laws that govern uses of wetlands.

EVALUATION

1. **For Younger Students:**
   What is a wetland? Name three reasons wetlands are important. Wetlands are sometimes called nurseries because so many young animals grow up in them. Name some animals that spend part of their lives in wetlands.
   For Older Students:
   Why are wetlands called one of the world's most productive ecosystems?
2. Wetlands are important to a range of organisms in the animal kingdom, from zooplankton to humans. Select five species of animals, and describe how wetlands are important to each.

REFERENCES

State or federal wildlife officials and representatives of private conservation or nature-related organizations can be helpful. (See Appendix C for North Dakota Agencies and Organizations associated with Wetlands Conservation.)

Golden nature guides from Western Publishing Company, Inc., are also useful.

National Wildlife Federation. 1989. Wading into Wetlands, Nature Scope series volume 2, number 5, Washington, D.C.

SUGGESTED VIEWING

Video - "Timeless Treasures" (#515-4). This video can be obtained by writing:

NDSU Extension Service
Media Library
Box 5655, Morrill Hall
Fargo, ND 58105-5655

EROSIONAL FORCES

ABSTRACT

SUMMARY:
Through the use of several teacher's models, students will observe the effect of erosion on a wetland, and how plants can help reduce erosion.

AGES: Grades Kindergarten to 12

SUBJECT: Science, Math, Geology, Agriculture Education, Geography, Social Studies, Language Arts

DURATION: 50 minutes (create model) and 30 minutes each week for 3 weeks

GROUP SIZE: whole class or in small groups of 2 to 4 students

SETTING: indoors

SKILLS: Comparing Similarities and Differences, Description, Discussion, Measuring, Observation, Prediction

INTENDED LEARNING OUTCOMES

Students will learn the causes of erosion and factors that affect the rate of erosion. They will learn that succession of an environment is a natural phenomenon that can be accelerated or slowed by human actions. They will also learn about natural erosional forces and how human action can accelerate these forces.

RATIONALE

The students will observe firsthand erosional forces and be able to see, measure, and identify components of these forces. Students should develop an understanding and appreciation for the various roles that wetlands play.

STUDENT PRIOR KNOWLEDGE

Students should understand that gravity causes water to flow to the lowest point. Students should understand that water is essential to every living organism. Students should have some knowledge of how all living and non-living things are co-dependent.

BACKGROUND

Succession is a natural progressive change in the plant and animal life of an area. A wetland is a good example of natural succession. Wetlands are lands in transition between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Over a long period of time through the process of succession, an aquatic environment will naturally change to a terrestrial environment.

The succession of a shallow wetland to a terrestrial area can be accelerated by humans. Sedimentation is an erosional process

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a; 2a,c; 3a,b,e; 4b,c; 5a,b
SCI (5-8) 1a; 2a,c,g; 3a,c,f; 4a,b,c; 5a,c,d,e
SCI (9-12) 1a,c; 2a,b,f; 3a,c,d; 4a,d,e; 5d,e

MATH (K-4) 1b; 3a; 4a; 8c; 10b; 11a,b
MATH (5-8) 1b; 4a,b; 10a; 11a
MATH (9-12) 3c; 4c; 10a; 11a
SOC (K-4) 11d; 13a
SOC (5-8) 11a; 13a
SOC (9-12) 11a,b; 13b
LANG (K-4) 2a,f; 3a,c; 4a
LANG (5-8) 2a,b; 3a,f; 4a,e,g,j
LANG (9-12) 2a,f; 3a,i

KEY VOCABULARY: erosion, evapotranspiration, filtration area or buffer zone, sedimentation, slope, soils, succession, wetland

that accelerates succession in wetlands. Soil sediments from surface water run-off can carry upland soils into a wetland. How much soil runs into the wetlands depends upon soil type, surrounding land use practices, topography, and precipitation events. Studies have shown that twice the amount of sediment runs into wetlands with row crops surrounding the wetlands, than those wetlands with vegetated uplands. Sediment run-off can be slowed by altering land use practices that encourage soil conservation.

MATERIALS

1. Student Observation Page (See Photocopy Booklet) and pencil (one student page and pencil for each student or group of students). The shaded area is for use with Extension #1.
2. Soils with different textures (i.e., sand, potting soil, black dirt)
3. Three - 9" x 13" pans (one for each soil type), aluminum baking pans, or flat container large enough to allow for the flow of water over the model
4. Sponge and scissors
5. Water
6. Grass seed and/or water plants
7. Watering can or spray bottle
8. Optional: fans, heaters, etc.

PROCEDURE

1. Depending upon student age, have the students plan and/or assist creating three different wetland models. Or, the teacher may wish to create the models in advance. Each model should include a wetland (at one end), surrounded by a sponge layer (this can be any thickness), with a layer of damp soil. Each model should have a different soil type, from fine to course textures, to use in the model. The sponge will represent a buffer zone surrounding the wetland. The soil area should slope into the wetland.
2. Depending upon student age, students should record their observation during the demonstration on the attached student observation page. Or, for younger

students, the teacher may wish to record student observations on the chalkboard. First, have them predict what will happen to each model's soils and wetland with various precipitation events.

3. Proceed with the demonstration by placing the pan on a slant with the wetland at the lower end. Using a spray bottle, have the students simulate different precipitation events (e.g., light shower to heavy rain) for the same length of time. Depending upon student age, have them record on their observation pages the type of precipitation event and the results.
4. The teacher and students should then measure as accurately as possible the amount of erosion for each soil type (model) and for each precipitation event.
5. Each model should then have grass seed planted in the buffer zone (sponge). Add a plentiful amount of grass seed.
6. Water the buffer zone area so the sponge stays moist for the grass to grow, and continue to keep the area moist.
7. After a week of grass growth, have the student repeat steps 4 and 5. Continue to revisit the model each week, for the next three weeks, and repeat steps 4 and 5.
8. Each week have different students or student groups present the results of the models to the class.
9. Discuss with the students how the amount of soil erosion into the wetland changes with the growth of grass, and why it has changed. Include in the discussion how the soil type, topography, land use, and kind of precipitation event influence the rate of erosion. Also, discuss how the soils deposited in the wetland accelerates succession of the wetland.

EXTENSIONS

1. Students could then create a situation of human intervention (such as overgrazing of the buffer zone, draining the wetland, tilling the vegetation next to the wetland, etc.) and continue to measure the amount of erosion happening. The same type of intervention should be applied to all three soil types (models). Comparisons should be made between the rate of natural erosion (with good grass covered buffer area) and the new rate following human intervention.

a. Students could then predict benefits and/or detriments of human intrusion into the natural process of succession.

2. Students could seal the top of their containers with plastic and watch the water cycle as the growing grasses transpire water and it condenses on the covering material. Older students will be able to note that this is the evapotranspiration that happens in any wetland area. Students can modify their environment by moving it closer to a heater or blowing a heater or blow dryer over the area. They could also turn on fans over the area to create the effect of the winds and note the changes or rate of changes in evapotranspiration.
3. Students can use line levels to measure the slope of different areas of the playground and note the changes caused by rains, winds, or by routine watering of the school yard.
4. Students could note the flow of water and changes caused by melting snow in the spring.

EVALUATION

1. Students can draw a new wetland area and describe the various components, explain their function and how much soil erosion may occur with different precipitation events. Have the students describe how different farming practices may affect the wetland. Or, have the whole class participate in a discussion of the farming practices aspect.
2. Students could compare rates of natural erosion to that erosion that might occur due to human influence on the earth.
3. Students could describe a real wetland in terms of its stage of succession and be able to defend their conclusion or evaluation of that wetland area.
4. Student observation pages.

TO ADD OR NOT TO ADD?

ABSTRACT

SUMMARY:
Students will see how pollutants can affect wetland organisms.

AGES: Grades 4 to 10

SUBJECT: Science

DURATION: One 50 minute period, and five 20 minute daily observation period

GROUP SIZE: whole class or small groups

SETTING: indoors or outdoors

SKILLS: Discussion, Experimental Control, Experimenting, Observation, Prediction, Writing, Reporting, Small Group Work

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a; 2a,c; 3a,e; 4b; 5a
SCI (5-8) 1a,b; 2a,c,g; 3a,c,f; 4a,b,c; 5c,e
SCI (9-12) 1a; 2a,b,f; 3a,d,h; 4a,e; 5e

INTENDED LEARNING OUTCOMES

Through observation, students will learn about factors that may damage water and wetland resources.

RATIONALE

It is important that students be made aware of man's influences on water and wetland resources. This hands-on classroom activity will increase student knowledge of pollution and its effects on wetlands and water.

STUDENT PRIOR KNOWLEDGE

Students should know that there are many different life forms found in wetlands. They also should understand what is pollution and its harmful effect on plant and animal life, including humans. Students should know what a wetland looks like and realize that wetlands have many different values and uses. Students should understand experimental variables and control.

BACKGROUND

Water covers about three-quarters of the earth's surface and is the most common substance on earth. Of the earth's water, 97.2% is found in the oceans and in not drinkable, 2.1% is fresh water locked in the polar icecaps. The remaining 0.6% of the earth's water constitutes the worlds fresh water supply. The world's water supply is used for many purposes such as drinking, laundry, bathing, sewage treatment, fish and wildlife habitat, power generation, transportation, and irrigation. The quality of water effects our health and livelihood. The maintenance of clean surface water and groundwater is important to all North Dakotan's.

KEY VOCABULARY: aquatic invertebrate, biodegradable product, fertilizer, insecticide, pollutant, wetland

Pollutants are harmful to aquatic life and water resources. In North Dakota pollution results from agricultural insecticides and fertilizer that run into wetlands and streams, domestic animal waste, and household garbage. Pollutants such as insecticides can kill the aquatic insects or invertebrates that are at the base of many food chains. Fertilizers can cause algae populations to grow or bloom to the point that algae blocks out life giving sunlight to plants.

Wetlands have the ability to improve water quality. Wetland plants and algae are adapted to use nitrogen and phosphorus which are present in commercial fertilizers. However, when a wetland is overloaded with pollutants, wetlands and the life within them are harmed. This activity will allow the students to experiment with different substances and determine their effect on wetland life.

MATERIALS

1. Eight to ten clear quart canning jars with lids
2. Wetland water, soil, plants and insect life
3. Masking tape and markers to label jars
4. Samples of pollutants the students would like to test (e.g., soap, garden fertilizer, salt, baby oil)
5. Extension - Microscope

PROCEDURE

1. Collect wetland plants, soil, insects and water for placement in experiment jars. The teacher can bring this to the classroom or the students could help with the wetland materials collection.
2. Fill the jars with wetland water, soil, plants and aquatic organisms. If you wish, have the students help fill the jars, however this could get messy!
3. Discuss pollution of wetlands and aquatic resources.
4. Discuss the contents in each jar: water, soil, plant and animal life. You may have the students view the aquatic life under a microscope.
5. Before adding the pollutants, the jars should be left over night to allow the disturbed soils to settle to the bottom.

6. As a class, list the pollutants that will be tested in each jar. Examples include: baby oil, soap, biodegradable soap, salt, garden fertilizer, screens, metals, insect repellent (spray or lotion), safe household cleaners, etc. One jar should be left uncontaminated as a control.
7. Have the students predict what will happen in the jar after each substance is added.
8. Students should observe each jar prior to adding the pollutant. Students could be placed into small groups and assigned one or two jars to observe. Observations should be kept in a journal.
9. Label the jars. Have students add the different pollutants (e.g., oil, fertilizer, salt...).
10. Have students record in journals daily what they see in the jars, and any changes that occur.
11. Hold group comparisons and discussions every 2 to 3 days.
12. After 5 to 10 days of observation, have a final classroom discussion of the experimental results and discard the materials.

EXTENSIONS

1. The experiment could be enhanced by observing the effect of different quantities of pollutants, or the effect of full or no sunlight.
2. Pollutants could be combined, and changes observed.
3. Use a microscope to observe microscopic life.

EVALUATION

1. Have students write a summary using information from their journals. The summary could be in several forms, including graphs, drawings, paragraphs, etc.
2. Have each small group predict, observe and evaluate the results and come up with written conclusions from the experiment.
3. Have each group discuss with the entire class what happened with their jar(s).

CAN IT

ABSTRACT

SUMMARY:
Students will learn how nonpoint source pollution can enter a wetland.

AGES: Grades 5 to 12

SUBJECT: Science, Social Studies, Language Arts, Music

DURATION: Activity- 40 to 50 minutes, Student rap- 50 minutes

GROUP SIZE: whole class or in small groups

SETTING: indoors

SKILLS: Communication, Discussion, Experimenting, Observation, Writing, Singing

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (5-8) 1a; 2a,g; 3a,f; 4a,b; 5e
SCI (9-12) 1a; 2a,f; 3a,c,h; 4a,d,e; 5e
LANG (5-8) 2b; 4a,e,g,j
LANG (9-12) 2a
SOC (5-8) 7a; 11a
SOC (9-12) 11a,b; 13b
ART (5-8)-music 2a,b
ART (9-12)-music 2a,b

INTENDED LEARNING OUTCOMES

Students will learn some of the causes of nonpoint source pollution and how it enters a wetland.

RATIONALE

This activity shows students how pollution can enter a wetland, other surface water, and groundwater.

STUDENT PRIOR KNOWLEDGE

Students should understand the key vocabulary.

BACKGROUND

Surface water and groundwater are two of North Dakota's most valuable natural resources. Nonpoint source pollution is a major factor affecting surface water quality and is receiving considerable attention at both the national and state level. The Environmental Protection Agency defines nonpoint source pollution as pollution caused by widely spread sources that are not regulated as point sources and normally is associated with agricultural, urban run-off, and run-off from construction activities, etc. Nonpoint source pollution does <u>not</u> result from a discharge at a specific single location (such as a pipe) but generally results from land run-off, precipitation, atmospheric deposition or percolation.

The run-off of rain and snow melt from farms and urban areas is the most serious of remaining water pollution problems. The nonpoint source pollution impacts to surface water is primarily attributed to agricultural activities. Groundwater impacts have resulted from agricultural chemicals, leaking underground petroleum storage tanks and pipelines, waste water

KEY VOCABULARY:
atmospheric deposition, groundwater, nonpoint source pollution, percolation, run-off, surface water, watershed, wetland,

impoundments, solid waste disposal sites, oil and gas exploration activity and septic systems.

Wetlands are a major source of surface water in North Dakota. Prairie wetlands are also associated with groundwater systems. Groundwater recharge only rarely occurs over upland and is "depressional focus," i.e., it occurs in wetlands where water is ponded. Since wetlands are associated with groundwater, the pollution of wetlands will have an effect on the quality of groundwater. Currently 60 percent of North Dakotans and virtually all rural North Dakotans use groundwater for drinking water. Ninety percent of North Dakota communities rely on groundwater for municipal uses.

MATERIALS

1. 9" x 13" cake pan
2. Sand, wet
3. Water
4. Freezer - ice cube with lots of red food coloring in it

Extension #1:
1. Pat of butter
2. Six paper clips
3. Few drops of Dawn® dish soap

Extension #2:
1. Clear jar or container
2. Cup of water from a wetland or lake which contains a lot of insects
3. Few drops of vegetable cooking oil

PROCEDURE

1. Make a teachers wetland model in a 9" x 13" cake pan with some wet sand. At one end of the pan, create a wetland that will hold standing water. The other end of the pan should be flat sand, and represents the watershed of the wetland. Discuss with the students why the wetland occurs in the depression in the sand, and from where the wetland receives its water. It will help to slightly elevate the end of the pan not containing

the wetland to simulate and quicken the drainage of water into the wetland. Within the wetland's watershed (the flat end), several harmful practices could be occurring:

Potential Problem Examples:

a) An old unused insecticide can is leaking, represented by the red ice cube. The insecticide is in a very concentrated potent form right now. Usually when insecticides are used they are diluted with water, and then sprayed on crops. (If you don't want to use the ice cube, you could put some red colored water in an empty spray bottle and "spray" the flat end like a producer would spray pesticides on crops.)

b) Or - An underground storage tank of gas or oil has a crack. This would be represented by a buried red ice cube.

2. Place two to three ice cubes with food coloring on the surface of the sand. Place the pan on a heater or in the sunlight to quicken the melting of the ice cube. You will need some time to let the ice cube melt or let the red spray seep into the groundwater. You may need to step away from the activity and come back to it, once you see the red coloring in the wetland.
3. This will demonstrate how pollution from leaking cans or storage tanks (either on a farm or city) several miles away or how spray from a field can seep into a wetland through surface run-off or groundwater sources.
4. Discuss with the students what effect pollution could have on the wetland and its inhabitants.

EXTENSIONS

1. Floating paper clips representing ducks that are "killed" by pollution from the insecticide can.

   * Teachers try this ahead of time to see if it works in your area with your water. Some chemicals in local water alters the effect. If it doesn't work, use distilled water.

a. Rub a few paper clips with real butter, not margarine. Place them gently on the top of the water - they should float and can represent ducks in the wetland or insects that walk on top of the water.

b. When pollution enters the picture, it breaks down the oil on their feathers or on their body and they can't float.

c. Dip your finger in some Dawn® dish soap and stick it in the water. After just a few seconds the paper clips will all sink to the bottom, drowning the ducks or killing the insects.

d. Pollution has broken down their natural "oil."

2. Real bugs killed by vegetable cooking oil as it represents the pollution that enters the wetland.
   a. Bring some insects from a wetland or lake and put them in the water so the students can see them swimming and floating around.
   b. Put a few drops of vegetable cooking oil in the water.
   c. Students can see the effect pollution has upon the insects.
3. Have them make up a "Wetlands Rap Song" about what happened to the ducks and wildlife in this wetland because of the pollution that leaked from the insecticide can or buried petroleum tank.

Rap Song Sample:

Some dude who had a can
left it sitting on some land
the can, it sprung a leak
and into the ground did seep
the poison sunk through soil and sand
and crossed over into the wetland
Death and destruction were everywhere
caused by this dude who didn't care

EVALUATION

1. Have the students diagram what happened in the pan.
2. Have the students discuss possible sources of nonpoint source pollution near where they live, and discuss possible solutions to these pollution problems.

WATER IN . . . WATER OUT . . .

ABSTRACT

SUMMARY:
Through observation, students will learn the role wetland plant's play in the water cycle, wetland, and in pollution filtration.

AGES: Grades 6 to 12

SUBJECT: Science, Social Science, Earth Science

DURATION: one 45 to 60 minute period, and 10 minutes daily over several days

GROUP SIZE: whole class or in small groups

SETTING: indoors

SKILLS: Experimenting, Interpretation, Measuring, Prediction

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (5-8) 1a; 2a,g; 3a,c,f; 4a; 5e
SCI (9-12) 1a; 2f; 3a,c,d,h; 4a; 5e
SOC (5-8) 11a; SOC (9-12) 11a;

INTENDED LEARNING OUTCOMES

Students will be able to describe how plants remove pollutants from water (filter), and understand the plant function in the water cycle (transpiration). Students will also understand the process in which water moves through plants (capillary action).

RATIONALE

This activity will illustrate the importance of wetlands and wetland plants by demonstrating how plants take up pollutants from the water, act as a filter, move water and release water through transpiration.

STUDENT PRIOR KNOWLEDGE

Students should understand plant anatomy, the water cycle, transpiration, and the movement of water through plants.

BACKGROUND

Plants are vital to our state's healthy water supply. In North Dakota, several industries and cities use wetlands to treat waste water. Wetlands are used because their plants help filter pollutants out of waste water.

Wetland plants trap particles of sediments in their stems, leaves and roots. As water moves through them, the wetland plants remove the excess nutrients and pollutants. These nutrients are stored in plant tissue or used by the plants for growth and metabolism.

Wetland plants are efficient at keeping nutrients and pollutants within the wetland and passing along clean water. However, if this natural system gets over loaded the plants can not filter all the pollutants out.

KEY VOCABULARY:
absorption, anatomy, capillary action, control, evaporation, filters, pollutant, stomata, transpiration, vascular system, wetland, xylem,

MATERIALS

1. Wetland plant with its root (e.g., cattail)
2. Gravel
3. Two beakers or clear glass containers
4. Measuring cup
5. Red food coloring and tap water
6. Magnifying glass
7. Masking tape and marker
8. Clear plastic bag

PROCEDURE

Day 1:

1. Collect or grow live wetland plants (e.g., cattails).
2. Prepare tap water by adding a generous amount of red food coloring.
   Ask students what the food coloring might represent? Ask for examples of pollutants that get into our wetlands? For example: sewage, pesticides, oil, soaps, and detergents.
3. Make one jar each of dyed and undyed water, and place an equal amount of liquid in each jar.
4. Place a clear plastic bag over several leaves of the plant.
5. Place the live plant in the dyed water jar and anchor the roots with the gravel. Leave the other jar as a control with only undyed water in it. Mark water level on jars.
6. Place plant jar and control jar in a sunny or well lit spot.
7. Explain or discuss the function of the control jar.
8. Have students write or draw the following predictions on paper:
   What will happen to the water in the control jar?
   What will happen to the water in the plant jar?
   What will happen to the pollutant (red dye) in the water?
   Why put a bag over the leaves of the plant?
   What will be in the bag tomorrow?
9. Student predictions could be collected and some could be shared as an introduction to the following day.

Day 2:

10. Share prediction from previous day.
11. Measure the water levels in each jar.
12. Students observe plant and control jars and discuss what they see.
13. Compare the results with their prediction.
14. You may consider having your students continue to re-visit the experiment daily for a week.
15. Ask the following question:
    Where did the missing water in the jars go to?
    {Some of the water evaporated (amount missing from control jar) and some was absorbed through the plant's roots.}
    Did the pollutants get absorbed along with the water? How can you tell? {The food color should be visible throughout the plant. This should also demonstrate the water's pathway through the plant.}
    Are there pollutants still left in the water? {Yes!}
    Where will they go? {In an actual wetland not all of the pollutants would be absorbed by the plants. Some of the pollutants absorbed by the plants may change once absorbed or be stored in the plant tissue. Also, as fresh water enters the wetland, pollutants that remain may become diluted.}
    Why was the water in the bag clear? Where did the water come from? {As the water is moved through capillary action from the plants roots to the leaves, moisture is released from the plant through pores (stomata) in the leaves and then evaporates into the atmosphere. The red dye will be absorbed into the plant tissue.}
    Why can't we dump all our waste into wetlands? {Wetlands can only do so much. An overload of pollutants can destroy a wetland. The best solution is to reduce pollution.}

EXTENSIONS

1. Cut cross-section of the stem and have students locate and identify the plant's vascular system. Dissect remainder of plant and search for stored pollutants (red dye).
2. Have students measure the amount of water that evaporated and was absorbed by the plant.

3. Have students measure the height of "pollutant" in the plant stalk.
4. Have students draw the "pollution sequence" in a wetland habitat. Start with how the pollution got into the wetland and end with how the pollution got out of the wetland.
5. Students can make cattail prints from various parts and pieces of the cattails that have been used.

EVALUATION

1. Have the students draw and label the components of the experiment on paper.
2. Have the students draw and label a water cycle.
3. Create a word puzzle using new vocabulary words, or use the crossword puzzle provided in the Photocopy Booklet.
4. Have the students complete comparative sentences such as: A plant in a wetland is a filter like a _____ is a filter. (Accept all appropriate answers like sponge, furnace filter, etc.)

SUGGESTED READING

Aadland, H. 1994. Devils Lake Lemna ... naturally. North Dakota Water. January 1994. (A copy can be found in the "Articles of Interest" section of the Guide.)

Rude, K. 1991. A Sweet Deal. Ducks Unlimited magazine. May/June Vol. 55, No. 3. (A copy can be found in the "Articles of Interest" section of the Guide.)

CROSSWORD PUZZLE ANSWERS -- Across = 1Natural; 2Evaporation; 3Transpiration; 4Pollutants; 5Anatomy; 6Capillary Action; 7Plants; 8Xylem; 9Water; 10Wetland
Down = 1Nutrients; 2Trap; 3Vascular System; 4North Dakota; 5Stomata; 6Filters; 7Absorption; 8Clean

WETLAND MODELS

*(Adapted with permission from **Ranger Rick's NatureScope - Wading into Wetlands**, published by National Wildlife Federation, Copyright, ©1986)*

ABSTRACT

SUMMARY:
Through the use of a teacher's model, students will discover how a wetland works.

AGES: Grades 3 to 12

SUBJECT: Science

DURATION: 40 minutes, with extension 90 minutes

GROUP SIZE: whole class
Extension - groups of 4 to 5 students

SETTING: indoors

SKILLS: Comparing similarities and differences, Description, Experimenting, Listening, Observation

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a; 2a,b,c; 3a,b,e; 4b,c; 5a
SCI (5-8) 1a,d; 2a,g; 3a,b,f; 4a,c; 5d
SCI (9-12) 1a,c; 2f; 3a,c,h; 4a,c,e; 5d

INTENDED LEARNING OUTCOMES

Students will learn about the water holding capacity of wetlands, and will understand how this wetland function is important to people.

RATIONALE

It's hard to tell, just by looking at wetlands, that they help filter silt and pollutants from water, help prevent soil erosion, and often reduce flood damage. But by building a simplified wetland model, you can demonstrate some of these important wetland functions.

STUDENT PRIOR KNOWLEDGE

No prior knowledge is needed.

BACKGROUND

Floods cause damage and losses to people and their property. Wetlands store water during heavy rain and during snow melt run-off. Wetlands serve as natural flood water storage reservoirs by allowing water to either evapotranspire to the atmosphere or slowly seep into the groundwater. Leaving watersheds intact by not draining wetlands, will not prevent flooding in lower portions of the watershed. However, draining wetlands in these watersheds will make flooding problems worse.

Studies in the Devils Lake basin of North Dakota have found that small wetlands could contain 657,000 acre-feet of water which is equivalent to about 72 percent of total run-off volume from a 2-year (or one in two chances of occurring) flood event

KEY VOCABULARY: acre-foot, basin, draining, evapotranspiration, groundwater, run-off, sediment, watershed, wetland

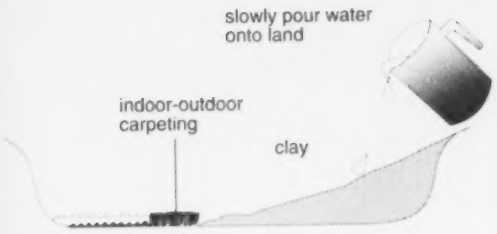
and about 41 percent of the total volume from a 100-year (or one in 100 chance of occurring) flood event. In an undrained portion of J. Clark Salyer National Wildlife Refuge, near Upham, North Dakota, wetlands retained all local run-off plus 58 percent of the water inflow. In another study, increased stream flows in the southern Red River Valley in North Dakota were strongly related to increase drainage in the watershed. An additional study of the Pembina River at Neche, North Dakota, compared run-off from a watershed with relatively intact wetlands with that of a watershed with large number of drained wetlands. Peak discharges at Neche were compared for the years 1904-1941 and 1942-1970. The study concluded that flood peaks after 1942 were significantly higher than prior to 1942, while average precipitation was similar. The higher discharges since 1942 were attributed to increased wetland drainage, changes in agricultural practices, or a combination of both.

Sediment entrapment is another aspect of pollution control that prairie wetlands provide to society. The nature of prairie wetlands is that they accumulate sediments that wash into the basin with run-off water. Trapping of sediments helps to maintain good water quality.

MATERIALS

1. Chalkboard or easel paper
2. Modeling clay
3. Oasis (florist foam)
4. Baking pan (9" x 13")
5. Small piece of indoor-outdoor carpeting
6. Scissors
7. Pictures of wetlands and wetland plants and animals
8. Water can or cup with water
9. Jar of muddy water
10. Extension - baking pans enough for each group, sponges, pine needles, twigs, grass, weeds, soil, and other natural materials, cotton swabs (optional), toothpicks (optional), cardboard, glue, scissors, paper and pencils, crayons or markers, reference books, poster paints

Diagram of Wetland Model



PROCEDURE

Before you begin the activity, make a demonstration model.

1. Spread a layer of modeling clay in half of the baking pan to represent land. Leave the other half of the pan empty to represent a wetland.
2. Shape the clay so that it gradually slopes down to the body of water (see diagram).
3. Smooth the clay along the sides of the pan to seal the edges. You can also form waterways in the clay that lead into the body of water.
4. Cut a piece of indoor-outdoor carpeting to completely fill the space across the pan along the edge of the clay (see diagram). The carpeting represents the wetland buffer between dry land and open water.
5. Begin the activity by asking the students to list the characteristics of a wetland. Write their answers on a chalkboard. Take a group survey to decide which of the characteristics might apply to all wetlands. (See activity background information in the "Wetland Functions" section of the *Guide*.)
6. Next show the group some pictures of different types of wetlands in North Dakota. Have the kids think about the animals and plants that might live in each kind of wetland. (See activity background information in the "Wetland Community" section of the *Guide*.)
7. Now demonstrate some of the functions of a wetland using the model. Explain that wetlands, like all habitats, are very complicated natural systems. And scientists are still leaning more about how they work. Scientists already know that wetlands perform some very important functions, such as filtering pollutants, reducing flood damage, and preventing soil erosion. Scientists also know that some wetlands, at times, help to recharge underground water supplies. Explain that your model will demonstrate some of these functions in a very simplified way.

8. Demonstrations with the model:

Flood Control: Fit a piece of carpeting into the wetland area. Pour some water slowly on the land, as shown. Have the kids describe what happens. (Some of the water is slowed down by the wetland plants (carpeting).) The excess slowly flows into the body of water (e.g., wetland, lake, stream or river).

Now remove the carpeting and water. This time pour the same amount of water on the model at the same spot and rate as before. Have the kids note any differences. (The water should fill the body of water much more quickly than before. That's because it's no longer buffered by the wetland plants. Explain that most wetlands are shallow basins that collect water and slow its rate of flow. This slowing process helps reduce flooding and also helps prevent soil erosion.)

Water Purification: Pour the water out of the model and replace the piece of carpeting in the wetland. Pour some muddy water from the jar onto the land. Ask the kids to compare the water that ends up in the body of water (e.g., wetland, lake, stream or river) with the water in the jar. (Explain that the soil particles are trapped by the carpeting (wetland), making the water in the body of water much clearer.)

Remove the carpeting (wetland), pour out the water, and try the experiment again. What happens without the wetland in place? Ask the kids why all the dirt particles end up in the body of water now. (The thick mat of plant roots in a wetland helps trap silt and some types of pollutants. Without a wetland, excessive amounts of silt and pollutants can end up in lakes, rivers, and other bodies of water.)

After demonstrating some wetland functions, discuss how wetlands are important wildlife habitats, as well as important recreation sites for people. (See activity background information in the "Wetland Community" section of the *Guide* for more about how wetlands are important to wildlife.)

EXTENSION

1. Divide your class into smaller groups of about five each. Tell each group they will be making their own wetland models out of clay, using the teacher's model as an example. (Instead of using indoor-outdoor carpeting to represent a wetland, have them use Oasis (florist foam) molded into a very shallow basin. Then the kids can attach plants and animals to the model with toothpicks.) Provide reference books or magazines so the kids can see pictures of the different types of wetlands. Then have them decorate the models according to the types of wetlands they are making. Here are some ideas:
   - For cattails, use cotton swabs painted brown, pieces of grass, or toothpicks painted brown with bits of brown clay stuck on the tops.
   - Use long pine needles for reeds.
   - Shape wetland creatures from clay or cut them from paper and glue onto toothpicks.
   - Make trees by gluing pieces of green sponge onto twigs.

EVALUATION

1. Have the students describe in writing the wetland functions demonstrated by the activity, and why wetlands are capable of these functions.
2. Older students could research in more detail and report on these two wetland functions.

REFERENCES

Hubbard, Daniel E. 1988. Glaciated prairie wetland functions and values: A synthesis of the literature. U.S. Dept. of Interior, Fish and Wildlife Service. Biological Report 88(43). 50 pages.

Kantrud, H.A., G.L. Krapu, and G.A. Swanson. 1989. Prairie basin wetlands of the Dakotas: a community profile. U.S. Fish and Wildlife Service. Biological Report 85(7.28). 116 pages.

WHO LIVES HERE?

ABSTRACT

SUMMARY:
This activity demonstrates how dissolved oxygen, pH and temperature determine presence of aquatic life.

AGES: Grades 7 to 12

SUBJECT: Science and Health

DURATION: 50 to 90 minutes

GROUP SIZE: whole class in small groups

SETTING: indoors or outdoors

SKILLS: Data collection, Discussion, Experimenting, Interpretation, Measuring, Graphing

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (5-8) 1a; 2a,b,c,g; 3a,b,f; 4c
SCI (9-12) 1a,c; 2a,b,f; 3b,c,d,h; 4e

KEY VOCABULARY: aquatic, aquatic invertebrate, dissolved oxygen, Hach kit, indicator, pH, temperature, tolerance levels, wetland

INTENDED LEARNING OUTCOMES

Students will learn that different water quality parameters such as pH, dissolved oxygen, and temperature help determine what kind of aquatic life is found in a wetland.

RATIONALE

To demonstrate the importance and influence of basic water quality parameters on aquatic life.

STUDENT PRIOR KNOWLEDGE

Students should have an understanding of pH and dissolved oxygen measures.

BACKGROUND

Many animals including humans have a tolerance range for certain physical factors, such as oxygen and temperature, under which they can exist and reproduce. Aquatic organisms have similar physical requirements. This activity looks at two physical requirements of aquatic invertebrates, dissolved oxygen and potential of hydrogen (pH). Dissolved oxygen is the amount of oxygen contained in the water. pH is a scale measure of acidity or alkalinity of the water. Aquatic invertebrates cannot survive in environments with pH or dissolved oxygen levels that are either too high or too low.

Since oxygen is a by product of photosynthesis, aquatic plants and algae contribute to oxygen levels in water. Because plants use the sun's energy for photosynthesis, the dissolved oxygen level increases throughout the day. Climatic conditions such as strong winds and heavy rain can cause slight changes in the pH or dissolved oxygen levels in a wetland. Strong winds can cause the water column to mix, and change both pH and

dissolved oxygen. Pollutants can cause more drastic changes in both pH and dissolved oxygen. Temperature also affects the dissolved oxygen level. Cold water can hold more oxygen than warm water. Scientists often monitor these water quality parameters to help them determine what causes changes in plant and animal communities.

MATERIALS

1. Six quart jars with lids to take water samples. Three jars should have the 100 mL. levels marked.
2. Water samples from three different sources such as a wetland, lake, stream, creek, or tap water.
3. pH key and dissolved oxygen table (attached).
4. Hach Kit to test dissolved oxygen. The kit contains instructions for testing. (For further information, on water quality and environmental investigation kits contact the State Water Commission at 328-4989.) Or, see the attached dissolved oxygen test procedure.
5. pH test paper or pH Hach kit.
6. Thermometer
7. Student data page (See Photocopy Booklet), one copy for each group or student. The shaded area is for use with Extension #3.
8. Overhead, to display tables of pH and dissolved oxygen ranges that support aquatic life (See Photocopy Booklet)

PROCEDURE

1. Bring to class two jars filled with water from three different water sources. The water samples to be used for dissolved oxygen test (100 mL. sample) will need to have the water temperature measured and oxygen level fixed, at the site of collection. To fix the oxygen level in the sample, follow steps 1 to 5 in the dissolved oxygen test procedures. The second water sample from the site will be used in the classroom to measure pH.
2. Hand out pH and dissolved oxygen table that is provided.
3. Using the pH paper or Hach kit, test or have students test the pH of each jar and record results (only allow

students to use kits under strict supervision - kits are expensive).

4. Using the attached dissolved oxygen test procedure or a Hach kit, test or have the students (older students) perform a dissolved oxygen test and record results.
5. Discuss with students their results.
6. Using pH and dissolved oxygen tables provided, discuss with students what kind of organisms may be living in the water and why.
7. Have the students predict how dissolved oxygen and pH levels will change as the water temperature is changed.
8. Have the students change the temperature of the water, then measure the temperature, dissolved oxygen level, and pH. The temperature change can be done by placing the sample in sunlight, heating the sample, or refrigerating the sample. Or, if the activity is used during field study, have the students measure temperature, pH and dissolved oxygen at different locations in the wetland. The locations could include sites with direct sunlight, shade, at the water surface, or one foot below the water surface. The students should record their results and compare the differences of the two measurements, and how temperature affects them.
9. Or, have the students during their field study measure the three parameters at the same site at different times of the day, and discuss why the measurements change.

Discussion questions may include:

1. What is pH?
2. What is dissolved oxygen?
3. What range of pH do northern pike thrive in?
4. What organism has the largest pH range?
5. What organism has the shortest pH range?
6. What amount of dissolved oxygen do most aquatic organisms require for life?
7. What level of dissolved oxygen do cold-water organisms such as caddisfly and mayfly require?

EXTENSIONS

1. Use the activity during field studies on wetlands, and have the students collect the water samples and conduct measurements in the field.
2. Identify aquatic organisms in water samples.

3. Discuss with the students what factors (e.g., wind, temperature, pollutants or salt) cause a change in pH or dissolved oxygen. Demonstrate to students how wind affects dissolved oxygen, by agitating the sample for different lengths of time and measuring the oxygen level and pH. Or, add different amounts of salt, to simulate pollutants, and demonstrate how that can affect both pH and dissolved oxygen. Have the students record their results and graph the changes.
4. Invite a water quality specialist guest speaker to your talk with your class. (See Appendix C - North Dakota Agencies and Organizations Associated with Wetlands Conservation.)

EVALUATION

1. Students will discuss and answer questions.
2. Have the students graph the changes in temperature verses dissolved oxygen and pH.
3. Have the students graph the changes pollutants (salt) cause the dissolved oxygen level versus pH level.

REFERENCES

U.S. Department of Agriculture. Investigating Your Environment Series -- Some Water Investigations. Forest Service, FS-349-4.

Hart, C.W., Jr., and S.L.H. Fuller. 1974. Pollution Ecology of Freshwater Invertebrates. Academic Press, New York.

American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 1985. Standard Methods for the Examination of Water and Wastewater. American Health Association, Washington, D.C.

Dissolved Oxygen Test Procedures

Materials:

Solution

A: Manganous sulfate solution*

B: Alkali-iodide-azide reagent*

C: Concentrated Sulfuric acid

D: 2% starch solution*

E: Standard sodium thiosulfate titrant*

Dissolved Oxygen Test Procedures

* Directions for Mixing Solutions

Solution A: Dissolve 480 g. of manganous sulfate ($MnSO_4 \cdot 4H_2O$) in distilled water, filter, and dilute to 1 liter. Keeps indefinitely.

Solution B: Dissolve 500 g. sodium hydroxide (NaOH)(or 700 g. potassium hydroxide (KOH)) and 135 g. sodium iodide (NaI)(or 150 g. potassium iodide (KI)) in distilled water and dilute to 1 liter. Then add sodium nitride (NaN_3) dissolved in 40 mL. distilled water. Keeps indefinitely.

Solution D: Dissolve 2.0 g. soluble starch and 0.2 g. salicylic acid (preservative) in 100 mL. hot distilled water.

Solution E: Dissolve 6.205 g. sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$) in distilled water. Then add 0.4 g. solid sodium hydroxide (NaOH) and dilute to 1000 mL.

Procedure: (20 drops = 1 mL.)

1. Measure out 100 mL. of your water sample into a small flask or beaker. For best results and to prevent agitation, while maintaining the opening dip the jar or flask into the water and allow the water to flow over the lip.
2. Add 10 drops of solution A with a dropper close to the surface of the water sample to avoid splashing.
3. With another dropper, add 10 drops of solution B to the same water sample.
4. Gently mix the water sample contents by swirling the flask being careful not to create bubbles.
5. Let sample stand for 1 minute. The oxygen in the sample is now fixed.
6. With another dropper, add 10 drops of solution C to the water sample.
7. Gently mix contents by swirling. While swirling add 5 drops of solution D to the sample. A blue color will appear.
8. With another dropper, add solution E drop by drop counting each drop. Continue adding until the sample becomes colorless.
9. Convert the number of drops of solution E to parts per million (ppm) of oxygen by dividing the number of drops by 20. Carry out your division to one decimal place.

THE WETLAND COMMUNITY

North Dakota's wetlands are a unique resource. Wetlands or prairie potholes are found in our state because of glacial activity that occurred more than 10,000 years ago. Today these basins that fill with water from spring snow melts and spring and summer rains provide homes or habitat for a large number of plants and animals. These plants and animals are uniquely adapted to their aquatic environment and are members of the wetland community.

North Dakota wetlands are diverse, they provide homes for a large variety of plants, animals, and insects. The inhabitants of a wetland may change dramatically during the growing season as some wetlands change from dry to wet and back to dry again. This ever changing and dynamic wetland environment is unique to the prairie, along with its wet and dry climatic cycles. Some wildlife associated with wetlands use the area during each phase of their life cycle while others may only use the wetlands during one part of their annual life cycle.

Of the 25 species of amphibians and reptiles in the state, 11 use prairie wetlands during all or part of their annual life cycle. Of the 223 birds species that reside or migrate to our state, 26 percent are marsh or aquatic birds, not including waterfowl. Waterfowl are particularly dependant upon North Dakota wetlands. During wet years, the Prairie Pothole Region in which North Dakota is included, produces over half of the continent's annual duck production.

North Dakota wetlands also provide summer homes for threatened piping plovers. During the summer, these birds use the shores of saline wetlands to nest and rear their young. The endangered whooping crane uses wetlands in the western half of the state during migration. The whooping crane migrates through our state in April on its way to breed at Wood Buffalo National Park, Northwest Territories, Canada and in September it flies south to Texas for the winter months.

Wetlands in North Dakota are also vital to the welfare of several mammals. Two of the most common are muskrats and beaver. However, beaver are associated with riparian wetlands and rivers. Wetlands are also vital to other wetland plants, invertebrates, insects and algae.

The plants in prairie wetlands change more dramatically than most other natural vegetation in North America because of the effects of regional climatic instability on water levels in the wetland. The kinds of plants found in a wetland are influenced by water levels in the basin, salinity, and disturbances by man.

PIN THE CATTAIL ON THE WETLAND

ABSTRACT

SUMMARY:
Students will become aware of the plants and animals found in wetlands.

AGES: Grades Kindergarten to 6

SUBJECT: Science, Art, and North Dakota Studies

DURATION: 40 to 90 minutes over one or two class periods

GROUP SIZE: 1 student to whole class

SETTING: indoors

SKILLS: Application, Description, Identification, Recognition, Visualization

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a; 2a,c; 3a; 5a
SCI (5-8) 1a; 2a,g; 3a
ART (K-4) visual art- 1c; 2a,c,e; 3a,b
ART (5-8) visual art- 1d; 2a,c,d; 3a,b

KEY VOCABULARY: wetland

INTENDED LEARNING OUTCOMES

Students will learn what makes up a wetland and what plants and animals live in a wetland.

RATIONALE

To help students realize the components of a wetland, this will also help with motor skills - cutting, pasting, and coloring.

STUDENT PRIOR KNOWLEDGE

No prior knowledge is needed.

BACKGROUND

North Dakota wetlands are a unique natural resource. Wetlands provide homes for a large diversity of plants such as sedges and grasses, birds, mammals, insects, amphibians and reptiles. Some plants and animals such as cattails and muskrats use the wetland exclusively for their annual life cycles. While other use wetlands only during part of their annual life cycles such as pheasants and deer which commonly use the wetland for shelter in winter.

MATERIALS

1. Large wall with white butcher paper, blackboard, or bulletin board
2. Draw a large cross section outline of a wetland
3. Scissors, tape, catalogs, magazines, thumb tacks
4. Blindfold (e.g., handkerchief, bandanna, scrap fabric)
5. Wetland pictures
6. Extension - string, straws, coat hanger (materials for mobile), and index cards

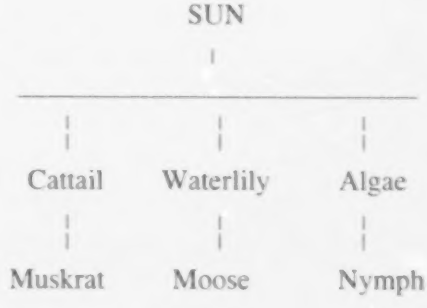
EXAMPLE OF WETLAND CROSS SECTION

PROCEDURE

1. Draw a large "rough" cross section outline of a wetland on a bulletin board, blackboard or on white butcher paper put up on the wall.
2. Students should cut pictures out of magazines or draw and color their own wetland creatures - be sure to include, plants, trees, birds, amphibians, reptiles, insects, and fish.
3. Put a circle of masking tape on the back of the pictures or use thumb tacks.
4. Have the kids take turns, place a blindfold on each student and turn them around, give them a photo and have them stick it in the proper place - whether it be a tree on the shore, a frog on a log, a turtle swimming, a red-winged blackbird on a cattail, a water skimmer on the water surface, etc.
5. Take the blindfold off and ask them if this is correct, if not allow them to move the picture to the proper location. Explain why it is or why it is not in the proper location, and where it should go. Ask them if they know the purpose or function of this plant or animal. Food chains should be brought into this discussion.
6. Display the bulletin board in the classroom or hallway for the whole school to see.

EXTENSIONS

1. With additional pictures have the students make a mobile of plants and animals that live in a wetland. This could be made in food chain form.



2. Using string and index cards form a web of life with the entire group using wetland plants and animals as examples. Students should hang a index card around their neck with a name on it of a wetland plant or animal. The string will be used to demonstrate how each plant or animal is linked.
3. Have the students research one animal or plant from a wetland. Have the student draw a picture and write a description of their selection.
4. Play a game of Charades® using wetland animals or Pictionary® in teams.

EVALUATION

1. During the activity students will discuss whether or not the pictures are placed in the right spot in the wetland.
2. Have students sketch and label the mural.
3. Have each student write a paragraph on the plant or animal they placed on the mural.

SUGGESTED READING

Hoberg, T. and C. Gause. 1992. Reptiles and Amphibians of North Dakota. Wild Facts of North Dakota.

WETLANDS IN DISGUISE

ABSTRACT

SUMMARY:
In this activity students will discover firsthand the value of animal camouflage.

AGES: Grades 1 to 8

SUBJECT: Science

DURATION: 20 to 30 minutes; Extension: 20 minutes

GROUP SIZE: whole class, as individuals or in pairs

SETTING: indoors

SKILLS: Application, Description, Mapping, Recognition

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a,d; 2a,c; 3a,e
SCI (5-8) 1a,b,d; 2a,g; 3a,c,f

KEY VOCABULARY:
adaptation, camouflage, predator, prey, upland habitat, wetland

INTENDED LEARNING OUTCOMES

The students will learn the role of an animal's surroundings to its protection from predators, or to aid in hunting effectiveness.

RATIONALE

To demonstrate the importance of the surroundings of healthy wetlands for the protection of the animals that live there.

STUDENT PRIOR KNOWLEDGE

Students should understand the key vocabulary terms.

BACKGROUND

Some animals have special adaptations to conceal them from their predators or prey, and they are masters of disguise. Color is one adaptation allowing the animals to blend into their surroundings. Camouflage enhances survival by making it difficult for predators to see their prey, and prey to see their predators. The American Bittern is a bird that nests and raises its young in wetlands. These birds have tan and white striped feathers. When the bird is disturbed it freezes and holds its beak up towards the sky to blend in with wetland plants thereby preventing detection. When wetlands are healthy they provide suitable surroundings for an animal to seek protection through camouflage.

MATERIALS

1. 10 - 20 small objects that are commonly found in a classroom. Ex. coins, comb, microscope slide, colored paper, paper clip, crayons, marker, pen, yardstick, ruler, etc.
2. Tape
3. Paper
4. Clock
5. Pencils
6. Student work page (See Photocopy Booklet)

PROCEDURE

1. Before class begins make a list of the objects to be used on the board or on an overhead sheet. Then using good camouflage techniques place the objects around the room (e.g., using a rolled piece of tape adhere coins to door or drawer knobs, use a dollar bill to cover the binding of a book on the shelf, adhere colored paper to match objects in the room). Use your imagination.
2. When the class enters the room tell them that you have placed some objects around the room that will represent the animals of a wetland. The students represent the predators (e.g., mink, great-blue herons, raccoons). Give the students a time limit of 3 to 5 minutes and have them record the places where the objects were found. For younger students use fewer objects and have them remember where they were or give them a map of the room to draw the object's position. Remind the students not to remove the animals from their habitats or help the other predators by telling them their locations.
3. Put up the list of objects (make sure they know what each of the objects represents) and tell them to start.
4. When time is up have the predators (students) return to their desks. The teacher should go through the list of objects recording the number of predators (students) that found each and give the location of the object.
5. Discuss what they learned by asking questions such as:
   Which "animals" would be the most likely to survive? Why?
   Which "animals" would be the least likely to survive? Why?

In a wetland how could an animal use camouflage to survive?
What happens when the "upland" habitat is removed?

EXTENSION

1. Before class the next day or after lunch recess place the objects around the room again but this time in obvious places and repeat the procedure used the previous day. Once again record the numbers of predators (students) that found the animals on the same overhead sheet or blackboard as before.
   Discussion might include -
   How did the numbers of animals found today compare with those found yesterday?
   Why was this so?
   What things could happen in a wetland to cause the same results?

EVALUATION

1. For older students, have each student prepare a map of where each object was found in the classroom.
2. Divide the class into two groups, and let one group camouflage some objects for the other group.
3. Have each student explain in writing how camouflage or an adaptation helps to protect prey or aid predators with hunting techniques.

LIST OF WETLAND PREDATOR AND PREY ANIMALS

Below is a list of wetland predator and prey animals that can be found in North Dakota wetlands.

Predators	Prey
Mink, Raccoon, Great-blue heron, Red-sided garter snake, Snapping turtle, White pelican, American bittern, Black tern, Belted kingfisher	Leopard or Tree frog, Tiger salamander, Fat-head minnow, Crayfish, Dragonfly, Mayfly, Ducklings (any kind), Snails, Leeches, Water beetles

THOSE THAT FLOAT... THOSE THAT DON'T

ABSTRACT

SUMMARY: Students will learn about aquatic insect niches and their role in a wetland community.

AGES: Grades 4 to 10

SUBJECT: Science

DURATION: 50 to 90 minutes

GROUP SIZE: whole class, in small groups of 3 to 4 students

SETTING: indoors or outdoors

SKILLS: Analysis, Classification, Comparing similarities and differences, Drawing, Identification, Interpretation, Observation, Prediction

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a,d,e; 2a,c; 3a,e; 5a,c
SCI (5-8) 1a,c,e; 2a,g; 3a,f; 4a; 5a,d

KEY VOCABULARY: aquatic invertebrate, community, food chain, niche, primary consumer, producer, secondary consumer

INTENDED LEARNING OUTCOMES

Students will be able to identify wetland organisms and place aquatic insects in their wetland niche. Students will be able to place these insects in a food chain within a wetland community.

RATIONALE

Each person in a community plays a role and performs certain functions that helps keep the community vital, such as a grocer and trash collector. The same is true of a wetland community, all organisms play an important role in the community that helps keep it healthy and vital.

STUDENT PRIOR KNOWLEDGE

No prior knowledge is needed.

BACKGROUND

Aquatic insects or aquatic invertebrates are the primary consumers in wetlands. These aquatic insects are the food source that amphibians, fish, mammals, birds, and reptiles depend upon. These insects use aquatic plant and algae materials for their growth and reproduction. Shorebirds and ducks during their migration depend upon these aquatic invertebrates to supply the necessary fat for them to complete their travels. These travels include trips to the arctic for summer and return trips to South America for winter. Even though North Dakotan's may only see some of these birds for a few short weeks each year, the birds are dependant upon North Dakota's wetlands to complete their annual migration and life cycle.

MATERIALS

1. Aquarium dip nets, or colander
2. Forceps
3. Aluminum pie pans
4. Magnifying glasses
5. Garbage bags
6. Bucket or tub
7. Shovel or hand trowel
8. For indoors, in advance collect a variety of wetland insects, including the plants, soil, and water
9. 2 liter pop bottles
10. Outdoors: wear hip boots or old tennis shoes
11. Identification books (e.g., Marsh World in WET Reference binder, and appendix from the Soil Conservation Service "Water Quality Indicators Guide: Surface Waters" found in the Photocopy Booklet.)

PROCEDURE

1. If the option of visiting a wetland with your class is not practical, then you may bring the wetland to your class.
2. (Indoors) In advance, collect a large amount of wetland plants (with roots), wetland soil, and water with insects, in a large plastic garbage bag placed in a tub.
   (Outdoors) Students may help collect insects near the shore. However, the teacher may wish to collect plant, soil and water samples from knee deep water and bring the sample to shore for examination.
3. Have students, using dip nets, colander and forceps, capture insects from the surface of the water, suspended in the water, attached to plants, and found in bottom sediments of the collected material from the wetland.
4. Place the insects captured in the aluminum pan with some water. Have the students compare the insects that were captured within different sections of the water column or within bottom sediments of the wetland.
5. Research food habits of wetland organisms and prepare food chains for the wetland community studied.

Food Chain Examples...
Energy → Producers → Primary Consumers → Secondary Consumers

Sun → plants → insects → ducks → humans
Sun → plants → surface insects → duckling → snapping turtle
Sun → plants → surface insects → frog → heron
Sun → plants → floating insects → turtle
Sun → plants → floating insects → minnow → gull
Sun → plants → bottom insects → diving ducks → mink
Sun → plants → bottom insects → fish → human

6. In a clear 2 liter pop bottle place pond water and all the insects that you have collected and identified. The insects will seek out different depths, because they have special adaptations for these specific locations. Students should observe the location of aquatic insects within the water column, then place that insect within a food chain, and be able to explain their value in a wetland community.
7. For older students, you may wish to identify these insects, with the identification books.

EXTENSIONS

1. For older students, place the insects to be examined in a small shallow dish with water. Using a magnifying glass or microscope, have the students compare the adaptations each aquatic insect has to enable it to live in different levels of the water column.
2. Discuss what might occur if these organisms were suddenly absent from the community.
3. Discuss how the food chains are interrelated using a food web.

EVALUATION

1. Have the students construct or draw a food chain found in a wetland community.
2. Have the students describe the importance of a wetland community in relation to food production.
3. Have the students draw the different insect adaptations, and describe in writing how the adaptations may help them survive in their niche.

SUGGESTED READING

MacDonald Junior Reference Library. 1969. Life in Fresh Water. MacDonald Educational, 49-50 Poland Street, London.

Overbeck, Cynthia. 1982. Dragonflies. Lerner Publications Co., Mpls. 48 pages.

Parker, Steve. 1988. Pond and River. A. A. Knopf, New York.

Reid, George K., Pond Life: A guide to common plants and animals of North American ponds and lakes. Golden Press, New York.

Robbins, Chandler S., Bertel Bruun, and Herbert S. Zim. 1983. Birds of North America: A guide to field identification. Golden Press, New York.

Zim, Herbert S. and Clarence Cottam. 1987. Insects: A guide to familiar American insects. Golden Press, New York.

NOT IN MY YARD

ABSTRACT

SUMMARY:
Through their sense of smell students will learn about territories, and what components animals need in their territories.

AGES: Grades 3 to 8

SUBJECT: Science, Language Arts, Library Media, and Social Studies

DURATION: 55 minutes

GROUP SIZE: whole class

SETTING: indoors or outdoors

SKILLS: Comparing Similarities and Differences, Description, Identification, Listening, Mapping, Using Time and Space

INTENDED LEARNING OUTCOMES

Students will learn about the four components of habitat, and how a territory relates to the survival of an organism.

RATIONALE

This sensory activity will allow students to become more familiar with the animal behavior of marking territories. The activity demonstrates what each animal needs within its territory, the importance of basic needs, and how a shortage of one need can cause a change in population levels.

STUDENT PRIOR KNOWLEDGE

No prior knowledge is needed.

BACKGROUND

Muskrats are commonly found in semipermanent and permanent wetlands of North Dakota. This mammal is well adapted to life in aquatic environments. Semipermanent wetlands are the most important habitat for muskrats because these basins are abundant, deep enough to sustain under-ice activity during winter, and support growth of cattails and bulrush. Muskrats build conical houses from aquatic vegetation such as cattails. Open water during part of the year is essential to their survival. These mammals eat primarily stems and roots of aquatic plants. However, frogs, salamanders, and fish are eaten occasionally. Muskrats mark their territory by leaving musky secretions on vegetation. A great amount of fighting takes place among territorial individuals especially when populations are high.

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a,d; 2a,c; 3a,b,e; 4b; 5a
SCI (5-8) 1a,e; 2a; 3a,f; 4a; 5d
SOC (K-4) 13a
SOC (5-8) 11a; 13a
LANG (K-4) 2a,b,e,f; 4a
LANG (5-8) 2a,b,e; 4a,e,g,j
LIBR (K-4) 1b,c
LIBR (5-8) 1b,c; 5b,d,e

KEY VOCABULARY: habitat, habitat components, limiting factor, territory

MATERIALS

1. Cotton balls
2. Scents - 1 scent for each territory (e.g., peppermint extract, lemon, anise extract, vanilla, vinegar)
3. Playground area or gymnasium
4. Covered container - 1 for each scent
5. Scratch paper or index card separately labeled with the four components of habitat - water, food, shelter and space. One set for each territory.
6. Marker to label cards or scratch paper

PROCEDURE

1. Identify a large playing area, indoor or outdoor, which can be marked off into 2 to 4 territories (e.g., playground, cafeteria, gym).
2. In advance, apply scent to cotton balls and place in separate covered containers. The number of cotton balls needed for each territory will depend upon the size of the territory. The territories can vary in size and shape.
3. Just prior to conducting the activity, mark each territory with different scented cotton balls. The territories should not overlap, however borders can be shared.
4. Place four separate pieces of scratch paper labeled with each component of habitat (food, water, shelter and space) within each territory.
5. Tell the students that the playground or gym represents a wetland.
6. Divide the students into as many groups as there are territories. Explain that each group is a family of muskrats, and they must locate their territory by matching the scent given to them with the scent around the territory.
7. Assign each group a scent. Give the students 5 to 10 minutes to locate the territory which matches their assigned scent.
8. Have them locate the habitat component cards for their territory. Discuss with the students what their personal needs are for survival and how their needs are similar to the needs of a muskrats and other animals. Like humans, animals need water, food, space, and shelter. Does the territory meet all of their needs for survival?

9. Remove from one territory the water resource. Have the students predict what will happen when a muskrat's habitat is short of one or more components. To survive the muskrat will be forced into another muskrat's territory. In this case, water is the limiting factor for the muskrats survival.
10. Discussion with your students:
    - Do you have everything within your territory that you need to survive?
    - What would happen if your group was deprived of one of your basic needs?
    - What would you do?
    - What would happen if you left your territory?
    - What would happen if you could not find what you needed?

EXTENSIONS

1. Have the students map all the territories.
2. Have the students brainstorm why some of the muskrats needs may not be met (e.g., drought, over population, wetland is drained or plowed, etc.).
3. How deep does water have to be before it freezes solid? And, how does snow cover and temperature effect the depth of ice?
4. Have the students research other wetland animals that mark their territories.

EVALUATION

1. Have students write a story about a year in the life of a muskrat.
2. Have students list or draw the components of a habitat, what a muskrat needs to survive, and what the students need to survive.
3. Have students describe the term "limiting factors" and list several examples of limiting factors that might influence muskrats and wetlands.

SUGGESTED READING

Messmer, Terry A., Robert W. Seabloom, Richard D. Crawford, Karen L. Kreil, and Ron A. Stromstad. 1987. Muskrat. Wild Facts of North Dakota.

SHOW YOUR COLORS

ABSTRACT

SUMMARY:
Students learn how color is used by animals for survival and reproduction.

AGES: Grades Kindergarten to 6; younger students will need help.

SUBJECT: Art and Science

DURATION: 60 to 100 minutes

GROUP SIZE: whole class, as individuals or in pairs

SETTING: indoors

SKILLS: Description, Drawing, Observation, Recognition, Visualization

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a,d; 2c; 3a,e; 5a
SCI (5-8) 1e; 2a,g; 3a,f, 5d
ART (K-4) visual arts- 1c; 2a,c; 3a,b; 4d;
ART (5-8) visual arts- 1d; 3a,b,c; 4c
ART (K-4) dance- 2a,c; 3a,b,c,d; 4a,b,c
ART (5-8) dance- 1b; 2a,c; 3a,c; 4c,d

INTENDED LEARNING OUTCOMES

Students will learn how animals use color to attract their mates, for protection from predators and prey, and defend their territory and mates.

RATIONALE

Color is important to the survival of animals in their environment. This activity demonstrates the importance of color to animals, and how color is used.

STUDENT PRIOR KNOWLEDGE

No prior knowledge is needed.

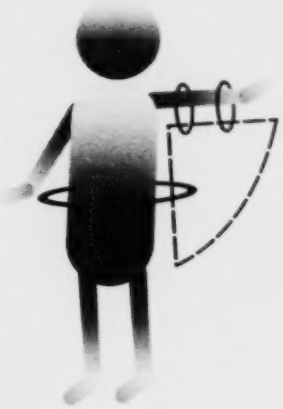
BACKGROUND

Animals have special adaptations for maintaining their species population. One of these adaptations is color. Bright color is often used to attract a mate, defend territories, or as a defense from predators.

Feather coloration in birds has numerous functions. When coloration serves to conceal the bird in its environment, it is considered camouflaged. Some birds have areas of color that become conspicuous when the birds are in flight. Their colored areas have a protective function, in that they deflect a pursuing enemy's attack from a vital to a less vital part of the body. Bright feather colors in males are a means of gender recognition. These bright colors in males also enhance displays prior to and during mating.

Waterfowl are a good example of birds using feather coloration for camouflage (hen ducks have drab colors), protection, gender recognition and enhancement of mating displays.

KEY VOCABULARY
camouflage, predator, protection, territory



MATERIALS

1. Colored construction paper
2. Large sheet of white paper
3. Color crayons, markers, water paints
4. String or elastic string
5. Scissors
6. Tape
7. Binder reinforcements

PROCEDURE

This activity may be adapted to use a variety of materials, so you can be creative in the materials you use.

1. Students will create colorful duck wings to wear. To get ideas of how duck wings are colored find pictures of ducks in magazines, books or field guides. Or you may have the student design their own color patterns.
2. Show and discuss pictures students bring to class.
3. Students will make wing patches for under their arms as shown in the diagram to the left.
4. Cut or have the students cut a triangular piece of paper large enough to fit between their outstretched arm and body.
5. Fold the paper like a fan.
6. Have the students color the inside half of folds with bright colors and the top half of folds black or brown.
7. Punch a hole in top and bottom of both sides of the wing. Reinforce the holes with binder reinforcements or tape.
8. Attach the paper wing to the upper arm, around the waist and wrist of the student with string. When the students arms are down it should look black or brown. When their arms are raised the wing will show the brilliant colors of the inside folds.
9. Discuss with the students the importance of color to animals.

EXTENSION

1. Have the students create a dance with the colorful wings to attract the attention of their bird mates.

EVALUATION

1. Have the students show the wing model they made and describe what it is for or how it is used.

MIGRATION HEADACHE

(Adapted with permission from Project WILD. © 1987, 1992 Western Regional Environmental Education Council)

ABSTRACT

SUMMARY:
Students role play migrating water birds traveling between nesting and wintering habitats.

AGES: Grades 4 to 12

SUBJECT: Science, Math, Social Studies

DURATION: 50 minutes

GROUP SIZE: whole class

SETTING: outdoor or large indoor area

SKILLS: Analysis, Classification, Comparing similarities and differences, Computation (limited), Discussion, Evaluation, Generalization, Hypothesizing, Inference, Interpretation, Listing, Observation, Prediction, Psychomotor development

INTENDED LEARNING OUTCOMES

Students will be able to list the factors affecting populations of migrating water birds, predict the effects of such limiting factors, describe the effects of habitat losses and degradation on populations of migrating water birds, and make inferences about the importance of suitable habitat for migrating water birds.

RATIONALE

For students to understand how North Dakota's wetland resources have not only statewide importance, but national and international importance, they need to understand the role North Dakota wetlands play in the annual life cycle of migratory birds.

STUDENT PRIOR KNOWLEDGE

No prior knowledge is needed.

BACKGROUND

Migration is a mysterious topic. How do birds, fish, mammals, and insects travel the immense distances they do with such exactness? Some travel at night, some during the day, some in the skies, and others deep within the sea. Yet unerringly they locate habitats necessary for the continuation of their species. Scientist have proposed that they use the stars, the sun and even the earth's magnetic field for guidance. Most probable, migrating species use a combination of means to guide their journeys.

There are a variety of remarkable migrating water birds. Many migrating birds--ducks, geese, swans, cranes, herons, rails, egrets, gulls, terns, and shore birds, for example--require the

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a; 2a,c; 3b; 4b,c; 5b
SCI (5-8) 1a; 2a,f,g; 3b,f; 4a,b; 5b,c,d,e
SCI (9-12) 1a,c; 2f; 3a,d,h; 4a,d; 5b,d,e
SOC (K-4) 11b,d; 13a
SOC (5-8) 11a; 13a,b
SOC (9-12) 11a,b; 13a,b

KEY VOCABULARY:
degradation, endangered species, habitat, limiting factors, migration, pesticide, pollution, population, water birds, wetland

presence of wetlands in their breeding habitat and on their wintering grounds. Since these two regions are often thousands of miles apart, they need wetlands to provide them with food and rest in between.

The populations of some species of water birds are healthy; however, populations of many water birds are showing a long-term downward trend. Examples of populations of species that appear to be healthy in most areas are Canada goose, goldeneye, ruddy duck, and green-winged teal. Examples of species that have experienced some decline but are now increasing are wood duck, sandhill crane, snow goose, and tundra swan. Examples of species that appear to be or are declining are American bittern, pintail, black duck, and canvasback duck. Among the species that are officially listed as endangered are piping plover, whooping crane, and Eskimo curlew.

The primary threats to the survival of migratory water birds are the disappearance and degradation of wetlands. Without wetlands, dozens of species of ducks, geese, swans, and other water birds face loss of the necessary habitat for survival. Many federal, state, and private groups recognize the importance of wetlands to wildlife. Millions of acres of wetlands have been purchased and protected to actively preserve and restore habitat for local wildlife and the vast flocks of migratory birds that span continents on their journeys.

There are international treaties and national laws affecting migratory species, including water birds, in the United States, the U.S. Fish and Wildlife Service has principal legal responsibility for managing migratory wildlife at the federal level. State wildlife agencies share some responsibilities with the U.S. Fish and Wildlife Service in protecting migratory animals.

The migration routes, or flyways, of North American water birds are well known. Before regulations, the market hunters of the 19th century took advantage of the fact that vast numbers of water birds would often concentrate at set points along these routes, and greatly decimated the flocks. Wetland habitats--usually found in low, fertile plains along water courses--were historically prized for conversion to farmland and settlements. Today, the journeys of water birds take them over lands on which human influences are ever increasing in scope and

magnitude. Agriculture, development, and industry are all reducing the availability of natural wetlands. Pollution, through pesticides such as insecticides and herbicides, as well as the use of lead shot rather than steel shot during hunting, all take their toll. There is new evidence to suggest that acid precipitation may be affecting insect populations which in turn affects the birds that depend on insects for food. Natural conditions also affect the migratory birds. Predators, weather, and disease influence both the animals and their habitat.

In this activity we have chosen to simplify the events of migration so as to keep the simulation manageable. In doing so we have avoided increasing the complexity of involvement between nesting and wintering areas. In actuality, many of the hazards faced by migrating water birds are hazards en route. We guide the teacher to emphasize these in discussion rather than during the simulation. Each student (assuming a class size of thirty) represents thousands if not tens of thousands of water birds. Thus, occasional losses to predation and other events of relatively minor magnitude during the course of migration are not emphasized in the simulation. The major purpose of this activity is for students to dynamically experience some of the important factors which affect the survival of migratory water bird populations.

MATERIALS

1. Large playing field or gymnasium, minimum of 70 x 40 feet
2. Two paper plates for every three students (clearly mark the plates to differentiate top from bottom), or use 12" by 12" carpet samples available at no cost from most carpet retail stores.

PROCEDURE

1. Select a large playing area about 70 feet in length. Place the paper plates in two patches one on each end of the playing field. Choose the number of plates so that you have one plate for each three students at **each** end of the field. Designate one of these areas the "wintering habitat" and the other the "nesting habitat." This means

you have two sets of plates; one set at the nesting habitat and one set at the wintering habitat.

2. Explain to the students that they are water birds and will migrate between these two areas at your signal. Tell them that the paper plates represent "wetlands." These wetlands provide suitable habitat for water birds. At the end of each journey, the students will have to have one foot on a paper plate in order to be allowed to continue. If they cannot get their foot on a plate, that means they have not found any suitable habitat. They "die" and have to move--at least temporarily--to the sidelines and watch. During migration, the birds may want to "flap their wings," moving their arms like birds in flight.
3. Explain to the students that many factors will limit the survival of populations of migrating water birds. Some involve changes in the wintering and nesting habitats. There will be times of abundant food, water, shelter, and space suitably arranged to meeting the habitat requirements of the birds. There will be other times when the habitat is stressed, with many factors limiting the potential for survival. Sometimes the area of available habitat is reduced. Tell the students that for purposes of this activity only three water birds can occupy a "habitat haven" (paper plate) at any one time.
4. Begin the activity with all the students at the wintering habitat. Announce the start of the first migration. Have the students migrate in slow motion until they become familiar with the process. Then they can speed up. On the first try, all the birds will successfully migrate to the nesting habitat.
5. Explain that there has been no loss in the area of available habitat. Thus, a successful nesting season is at hand.
6. Before the students migrate toward the wintering habitat, turn over one plate from the wintering region. Explain that a large wetland area has been drained. Repeat the instruction to migrate and send the ducks to the wintering habitat. Have the three students that will be displaced stand on the sideline. Tell the students that these three died as a result of loss of habitat. Remind any "dead birds" that they will have a chance to get back into the activity. They can come back as surviving hatchlings when favorable conditions prevail and there is habitat available in the nesting ground. **Note:** The

series of migration cycles can be graphed. Many teachers have chosen this method to record the cycles.

7. Before the next migration to the nesting region, turn over four plates in the nesting habitat. This represents a catastrophic loss. Tell the students that this is the result of an oil spill in the local river, severely damaging shoreline habitat. Instruct the students to migrate. **Note:** This results in a large number of students waiting on the sidelines to re-enter in the nesting habitat. Before many cycles are repeated, provide them with an opportunity for re-entry. Each time give the students examples of changes in the habitat conditions that could have taken place making it possible for them to survive. Two students can be made permanent monitors to turn the paper plates over as you instruct them.
8. Repeat the process for eight or ten migration cycles to illustrate changes in habitat conditions with resulting effects on the birds. Give examples of factors that might influence the birds' survival. (See the table below for suggestions.)

<u>Factors Limiting Survival of Populations of Migratory Birds</u>

- wetland drainage
- drought or severe weather
- pollution and contamination of water
- urban expansion
- conversion of wetlands to farm land
- conversion of natural waterways to canals
- illegal hunting, and lead shot in food supply
- predation
- disease
- etc.

<u>Factors Favoring Survival of Populations of Migratory Birds</u>

- preservation of wetlands
- adequate water supply for wetlands
- restoration of habitat
- human action aimed at protecting and restoring wetlands, including through education
- regulation of hunting
- etc.

Some limiting factors are a natural and dynamic part of any environment. This is true of factors favoring survival as well. However, the significant difference in the case of the survival of populations of migratory aquatic birds seems to be the loss or degradation of huge areas of suitable habitat, much of it as a result of human intervention, e.g., draining wetlands, pollution of water supplies.

Be sure to create one or more "disaster" years to illustrate catastrophic loss of large areas of available habitat. Remember that, overall, the availability of suitable habitats for migrating aquatic birds is diminishing--the activity should end with fewer areas of available habitat than can accommodate all the birds. There is general agreement that the greatest long-term threats to the survival of populations of migratory water birds is the loss and degradation of habitat.

9. In discussion, ask the students to identify the apparent causes of the birds' population decline from year to year. Ask them to try to imagine what seem to be the major factors contributing to habitat loss and degradation. Ask them to make predictions about the effects of these factors. Distinguish between short-term and long-term effects. Distinguish between catastrophic effects and gradual changes. Ask the students to support their hypotheses with evidence, seeking additional information through research if necessary.
10. Ask the students to summarize what they have learned about some of the many factors that affect the success of aquatic bird migration. List and discuss human-caused factors and environmental factors. Compare similarities and differences between these limiting factors. Highlight those which the students identify as posing the most significant long-term threat to the survival of migrating water birds.
11. What kinds of things can and should be done to protect and restore habitats for migrating water bird populations? Discuss potential tradeoffs related to any recommendations.

EXTENSION

1. Pick a species of water bird. Find out more about its characteristics. Conduct this activity again with each student representing a specific kind of water bird!
2. Explore the major factors affecting habitat loss and degradation, or gain and restoration, in your area. Research the causes for long-term habitat loss, as well as any major efforts underway to prevent these increasing losses.
3. Using a map, plot the major migratory routes of North American birds.
4. Visit a national wildlife refuge, state wildlife area, bird observatory, private sanctuary, or other habitat for migratory water birds.
5. What other animals migrate? Are the problems they face similar to those of migratory birds?
6. Find out who J.N. (Ding) Darling was and what he did for migrating water birds.
7. Find out about Ducks Unlimited. It's one example of a private organization dedicated to providing and protecting habitat for migratory water birds.
8. There are national laws and international treaties protecting migratory species. Find out about some of these. What is their history? Are they effective? Are there problems enforcing them? What migrating species, if any, are unprotected by such laws?

EVALUATION

1. Name two human activities and two environmental factors that might interfere with water bird migration. For each activity and factor, describe the possible effects on the water birds. Distinguish between effects on individual birds and effects on populations of birds. Indicate if an effect is short-term or long-term.
2. Why is suitable habitat important for migrating water birds? Include in your response a description of the different kinds of habitat that are needed by migrating water birds.

   True or false: Habitat loss is a greater threat to the survival of migrating populations than for stationary populations of wildlife. Explain your answer.

SUGGESTED VIEWING

Video - "Do Your Part" (19.5 minutes) This video may be obtained by writing:

N.D. Wetlands Institute
1501 N. 12th Street
Bismarck, ND 58501
Ph. # (701) 223-8332
Fax # (701) 223-4645

DICHOTOMOUS PLANT GAME

ABSTRACT

SUMMARY:
This activity uses a board game to show how a dichotomous key is used.

AGES: Grades 5 to 8

SUBJECT: Science

DURATION: 15 to 30 minutes

GROUP SIZE: whole class, in small groups of 2 to 3 students

SETTING: indoors

SKILLS: Classification, Description, Identification, Observation, Recognition

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (5-8) 1a,c,e; 2d,g; 4a,c

KEY VOCABULARY: basal, dichotomous key, descriptive words used in the key

INTENDED LEARNING OUTCOMES

Students will learn how to use a dichotomous key through this simple game.

RATIONALE

A dichotomous key is a basic tool scientists use for identification of plants and animals. This activity provides a simple and fun way to show how a dichotomous key is used and it also demonstrates differences in North Dakota wetland plants.

STUDENT PRIOR KNOWLEDGE

Students should know the meanings of the descriptive terms used in the game.

BACKGROUND

Wetland plants have special adaptations to survive in wet and dry wetland environments. Wetland plants help the wetland to function properly. They are particularly important for water quality purposes because plants help trap soil and some kinds of pollutants. These plants also provide food and cover for many wetland animals. Plants are one criteria that scientist use to identify a wetland. However, the area is still a wetland even if the plants are not there because wetland soils still remain.

This activity will provide your students an opportunity to learn how to use a plant identification key and allow them to become familiar with common wetland plants in North Dakota.

MATERIALS

1. Game board (See Photocopy Booklet)
2. Game cards (See Photocopy Booklet)
3. Index cards, glue or tape to attach backing to game cards
4. Clock

PROCEDURE

1. In advance, cut out eleven game cards and tape or glue them on to index cards. Tape together the game board. You will need one copy of the game board and game card set for each 2 to 3 person group.
2. Divide class into 2 to 3 person teams. Each team will have a game board and card set. The teams will compete with other teams and/or the clock.
3. Hand out a game board and game cards to each team.
4. Give the students directions for the game, as follows:

   DIRECTIONS:
   The object of the game is to find the name of each plant on the game cards using the game board (a dichotomous key). Look at one of the game cards and begin at the word 'start' on the game board and answer the paired 'yes' and 'no' questions on the game board. Continue with the next question on the branch in which you responded 'yes.' When you reach the end of a branch with a name, place the game card next to the name. Continue until all the cards are used up or the time limit is up. If you reach a branch that says "start over" you will know that you answered a question wrong and you are to go back to the 'start'. Depending on the amount of time available the game can be played until all game cards are used up or an amount of time can be set. The team with the most correct game cards in place 'wins'.
5. When finished, the teacher can hold up the correct answers and students can check their boards.

EXTENSIONS

1. Additional cards could be added to the deck and students could be asked where the plant would fit the best.
2. A game could be made for animals or insects.
3. Students could be given a group of objects and they could make their own dichotomous game board from the objects.
4. Take a class field trip to a wetland, and use the game cards to help identify the wetland plants you find.
5. Have the students bring from home wetland plant specimens. These specimens can be identified using the game board, a plant guide, or dichotomous key.

EVALUATION

1. Class discussion questions could include the following:
   a. Did you reach any dead ends? If so why?
   b. What other things could be put on the board?
   c. Why do you suppose the key is called dichotomous?
   d. Why do you think classification is so important?

REFERENCES

Ducks Unlimited Canada. 1991. Marsh World. (See WET Reference binder)

WETLAND SOILS ANALYSIS

ABSTRACT

SUMMARY:
Students will discover soil composition as it relates to water retention and drainage.

AGES: Grades 2 to 12

SUBJECT: Science, Math, Earth Science

DURATION: 60 to 110 minutes over a period of 2 days

GROUP SIZE: whole class, in small groups of 2 to 4 students

SETTING: Indoors or Outdoors

SKILLS: Application, Comparing Similarities and Differences, Discussion, Experimenting, Graphing, Listing, Measuring, Prediction, Small Group Work

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (K-4) 1a,e; 2a,b,c; 3a,e; 5a,c
SCI (5-8) 1a,b; 2a,c,d,g; 3a,f; 4c; 5a,d
SCI (9-12) 1a,b,c; 2b,d,f,g; 3a,b,c,h; 4e; 5d
MATH (K-4) 4a; 8c;
MATH (5-8) 2a; 4a,b; 10a,b
MATH (9-12) 1c; 2b,c; 4c; 10a

INTENDED LEARNING OUTCOMES

Students will discover the differences in various soil samples, that soils are made up of various amounts and sizes of soil particles, that different soils hold or drain water differently, and that soils have different benefits depending on use.

RATIONALE

Through this activity students will develop an appreciation of the water holding capacity of various soils and their drainage patterns. This activity provides a hands-on scientific style of discovery so students can feel, touch, measure, and analyze different soil samples.

STUDENT PRIOR KNOWLEDGE

Students need to know that soil consists of a mixture of different sized particles and materials.

BACKGROUND

Soil is a mixture of mineral, organic matter, water and air, and forms on the surface of the earth. Soils are formed by a combination of five factors: parent material, climate, living organisms, topography, and time. Depending upon the make up to the parent material, some material such as quartz (igneous rock) is more difficult to break down than shale (sedimentary rock). Parent material is broken down by weathering. Temperature and water are two climatic factors influencing weathering. Frequent freezing and thawing of water in rock cracks, and wetting and drying cause a break down of parent material. Plants and animals also help break down parent material and also provide organic matter to the soil and help make them rich in nutrients. Topography also influences soil formation. Hilly sites may have been eroded, are drier and

KEY VOCABULARY: clay, compaction, drainage, glacial till, groundwater, organic matter, parent material, particles, silt, soil, water table, wetland

have well drained soils. While low areas have poorly drain soils.

Soil type is one of the criteria that scientist's use to determine if an area is a wetland even though there may be no water in the basin. Wetlands have hydric or water-loving soils. North Dakota's glacial till derived soils are high in clays. Clay expands greatly when wet, and is the primary reason for wetland soils high water retention capability. Wetland soils are also dense, and this also increases a wetland's water retention capability.

The development of wetland soils depends strongly on length of flooding, water quality, and the relative position of the wetland basin with respect to the groundwater table. Wetland soils are saturated and flooded long enough during the growing season to develop anaerobic (lacks oxygen) conditions that favor growth or re-growth of water-loving plants.

MATERIALS

1. 3 clear quart jars of equal size with lids that seal tightly, preferably narrow clear plastic jars
2. 3 different soil samples: wetland soil, upland soil, third soil type. These could be brought in by the students.
3. Shovel and bucket, to collect soils
4. Cup to pour samples into jar
5. Rulers for measuring
6. Graph paper or other paper to record data
7. Masking tape and marker

PROCEDURE

1. Fill each jar about half full of tap water.
2. Label each jar to designate the soil sample that it contains.
3. Pour each soil sample into a jar until the water is nearly to the top.
4. Place a lid on tightly and shake vigorously until all the soil is suspended in the water. Let set undisturbed for 24 hours.

5. Let students observe periodically during the school day and note the types of particles that settle to the bottom first. Students will also note the clarity of the water as time passes.
6. After 24 hours observe the layers of sediment in each container.
7. Identify the layers of clay, silt, sand, gravel, and organic matter. Next measure the depth of each layer of sediment for each container and record and/or graph the information for comparison.
8. Have the students predict which soils are best for plant growth. Students can predict where each soil type will most likely be found and attempt to explain the reason for their choice.

EXTENSIONS

1. Students can extend this activity by planting a fast growing plant such a bean into each soil sample. Soil samples should be placed in a container that will allow the soil to drain freely. Students should note the water percolation or holding ability of each soil.
2. Students could design an experiment to discover the rate at which water soaks into various types of soils (You can use the same soil).
3. Students could hold a discussion based on the question: Does the type of soil and its location affect the rate at which it soaks up water?
4. Students could research and discover how groundwater soaks into various soils. Then students could attempt to explain the water table and the formation and/or pollution of aquifers and its affect on each of us in our daily use of water.
5. Students could research or discuss the use of the wetland areas in its role in cleansing the water supply before it soaks down into the deeper layers of earth.

EVALUATION

1. Have the students identify and list the characteristics of each type of soil studied.
2. Have the students construct a graph of components and compare and contrast the benefits and/or drawbacks of each.
3. Make additional unmarked jars and have the students identify where samples were taken.

SUGGESTED READING

Berryman, Bonnie and Deborah Schultz. Creative ways to cultivate agriculture in the classroom. North Dakota Department of Agriculture.

U.S. Department of Agriculture, Soil Conservation Service. 1985. Conserving Soil. National Association of Conservation Districts; The Communications and Education Group, a Division of the Mazer Corporation. 16 pages plus appendices.

U.S. Department of Agriculture. 1979. Soil Survey of Benson County area, North Dakota. National Cooperative Soil Survey. Please note that each county has its own soil survey book. (Call your county Extension Agent or Natural Resources Conservation Service to loan the soil survey book for your county.)

ALGAE SURVEY

ABSTRACT

SUMMARY:
This activity uses an algae survey to build skills in scientific techniques of classification, surveying, data collection, and graphing.

AGES: Grades 7 to 12

SUBJECT: Science and Math

DURATION: 60 to 100 minutes

GROUP SIZE: whole class, in small groups of 2 to 3 students

SETTING: indoors

SKILLS: Classification, Data Collection, Extrapolation, Graphing, Matching, Reporting

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (5-8) 1a; 2a,b,c,d,g; 3c
SCI (9-12) 1a; 2a,b,d,f; 3a,c,d,h
MATH (5-8) 1b; 2a,b; 4a,b; 7a,b; 8a,b; 10a,b; 11a,c
MATH (9-12) 1c; 4a,b,c; 7a,b; 8a,b; 10a; 11a,b

INTENDED LEARNING OUTCOMES

Students will learn how to develop observation skills, perform tasks needed to conduct a count, collect accurate data, and construct a graph of data collected, and predict outcomes based on graphed data.

RATIONALE

The scientific method of counting populations is important for understanding the interrelationships in a wetland. This activity develops skills in classifying, identifying and simulates making a count using a microscope.

STUDENT PRIOR KNOWLEDGE

Student should be able to use a picture identification key for algae.

BACKGROUND

Algae populations can be used as indicators of water quality. Algae populations are highest when nitrogen and phosphorus levels are high within a wetland. Prairie pothole wetlands are naturally fertile systems, producing nitrogen and phosphorus. However, when nitrogen or phosphorus levels are high, this can indicate that unnatural sources of nutrients are being imported into the wetland.

Wetland systems can be made increasingly fertile due to increased nutrient loads from waste water treatment and agricultural practices. Some sources of high nutrients can be from animal or human waste, or agricultural fertilizers. These nutrients can be carried into wetlands by surface water run-off, enter wetlands with eroded sediments, or be brought with water through sub-surface drainage.

KEY VOCABULARY: frequency distribution, identification key, nutrients, population, ratio, see key for names of algae, species, survey, water quality, wetland

Epiphytic algae, a type of periphyton, is an algal growth attached to plants. Epiphytic algae largely derive their nutrients from surrounding water. As the wetland becomes more fertile with nitrogen and phosphorus, algae feed off these nutrients and reproduce out-of-control. This high density of algae is called an algae bloom. It can be intense, and result in oxygen depletion throughout the water column and cause massive fish and invertebrate kills. However, nitrogen and phosphorus can be transferred from surface water of wetlands to the atmosphere, wetland bottom sediments, and to living and dead plant matter.

MATERIALS

1. Student activity page (See Photocopy Booklet)
2. Teachers Key (Those algae listed as 15b, 2b, etc. are found on the green algae key. The others are found on the blue-green algae key.)
3. Identification keys (See Photocopy Booklet)
4. Graph paper
5. Photocopy grid overlay (See Photocopy Booklet) on acetate to lay over student activity page (grid size to be determined by the age of participants). Rulers for drawing the grid on the activity sheet.

PROCEDURE

1. Instruct students to look at the student activity page to determine the different kinds of algae in the picture.
2. Using the identification keys students should identify and list the kinds of algae present.
3. Place acetate sheet over page and perform a count of each kind or organism shown, or have the students draw the grid directly on their activity page.
4. To perform the count -
   a) number each quadrant of the sheet
   b) prepare a data table to record information determined in the survey
   c) list organisms identified in step 2 on data table
   d) go through each quadrant counting the individual organisms and recording their frequency on the data table

5. Graph data
6. Questions:
   - Determine the frequency distribution for each species found in the population, or by quadrant.
   - Which quadrant contains the greatest number of algae?
   - Which quadrant contains the greatest number of different algae species?
   - Determine the ratio of green algae to blue-green algae.
   - If this data represents the numbers found in 1 quart of water determine the number of organisms that would most likely be in a 10 gallon aquarium?
   - Calculate this value for a 1 acre wetland with an average depth of 2 feet (1 acre-foot = 329,825 gallons).

EXTENSIONS

1. Conduct a similar survey of populations of organisms in and about a wetland.
2. Students suggest and explain where this technique would be appropriately used.

EVALUATION

1. Accuracy of count.
2. Appropriate construction of their graph.
3. Ability to apply count technique to another situation.

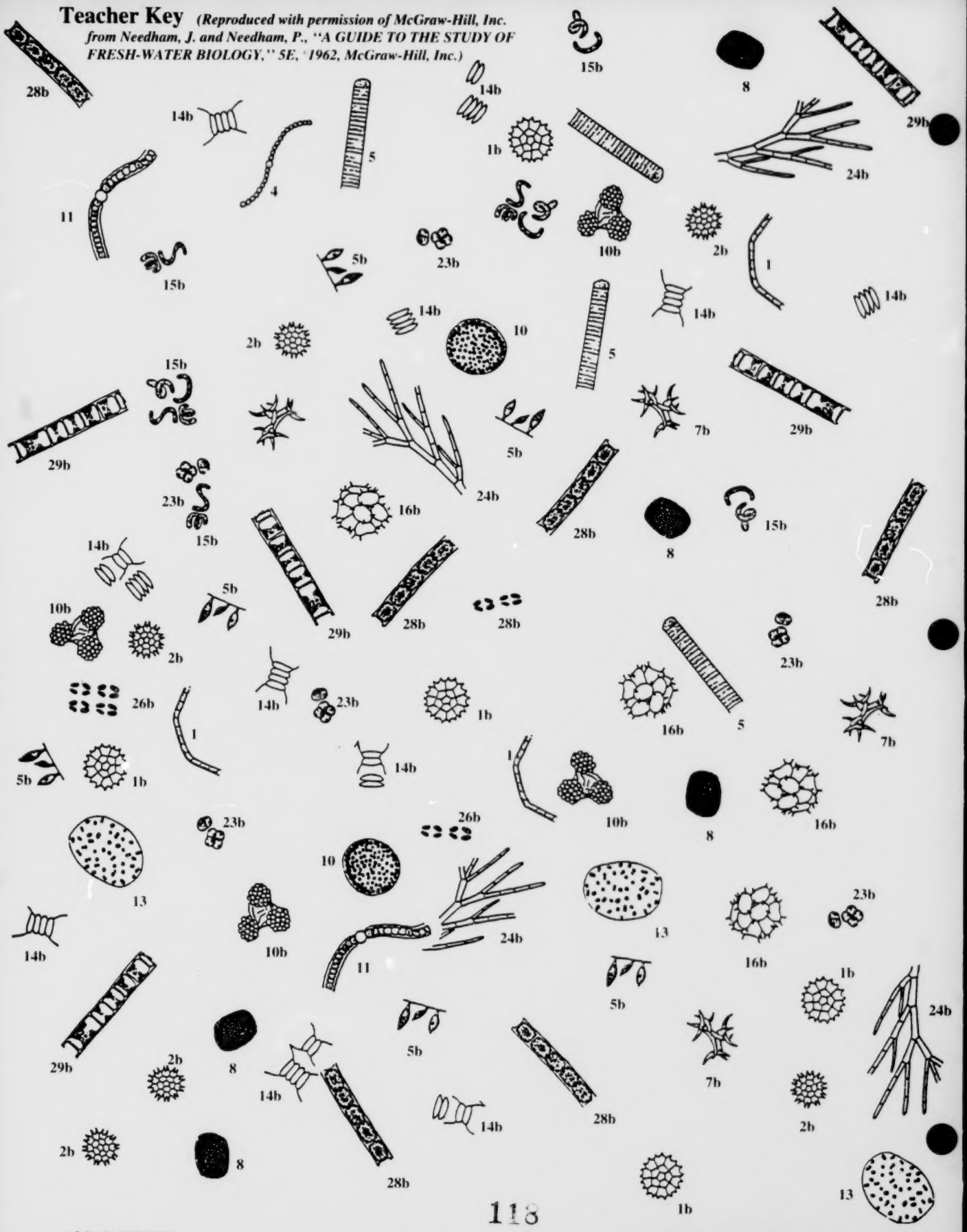
REFERENCES

Needham, James G. and Paul R. Needham. 1962. A guide to the study of Fresh-water Biology. Holden-Day, Inc., San Francisco, 5th ed.

van der Valk, Arnold, ed. 1989. Northern Prairie Wetlands. Iowa State University, Ames, IA.

Teacher Key

(Reproduced with permission of McGraw-Hill, Inc. from Needham, J. and Needham, P., "A GUIDE TO THE STUDY OF FRESH-WATER BIOLOGY," 5E, 1962, McGraw-Hill, Inc.)



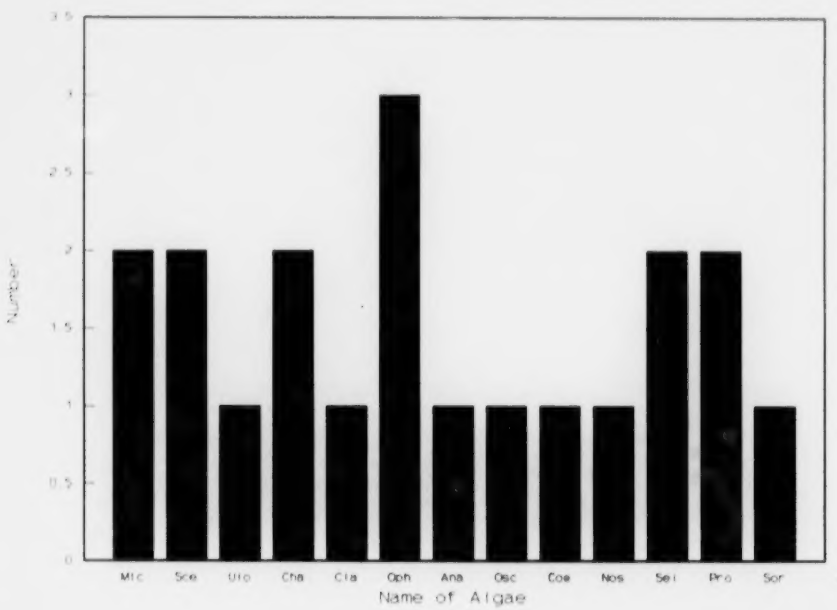
SAMPLE DATA SHEET

Quadrant Number _____

Name of Algae	Number Found in Quadrant	*Name of Algae*	Number Found in Quadrant
Pediastrum		*Phormidium*	
Microspora		*Anabeana*	
Scenedesmus		*Oscillatoria*	
Ulothrix		*Polycystis*	
Characium		*Coelosphaerium*	
Botryoccoccus		*Nostoc*	
Coelastrum		*Aphanocapsa*	
Ankistrodesmus		*Selenastrum*	
Cladophora		*Protococcus*	
Crucigenia		*Sorastrum*	
Ophiocytium			

SAMPLE FREQUENCY DISTRIBUTION

Quadrant Number 1 (upper left)



CONDUCTING AN ALGAL SURVEY

ABSTRACT

SUMMARY:
Surveys of algae populations in wetlands demonstrates a tool that biologists use to monitor wetland health.

AGES: Grades 10 to 12

SUBJECT: Biology and Science

DURATION: 60 minutes each week for three or more weeks

GROUP SIZE: whole class, in small groups of 2 to 4 students

SETTING: indoors or outdoors

SKILLS: Classification, Data Collection, Discussion, Experimenting, Graphing, Library Skills, Measuring, Prediction, Reporting

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (9-12) 1a,b,c; 2a,b,d,g; 3a,c,d,h

KEY VOCABULARY: algae, detritus, invertebrate, metaphyton, periphyton, phytoplankton, survey

INTENDED LEARNING OUTCOMES

The students will learn how to conduct a simple biological survey, collect data over a period of time and organize the data collected. They will also observe changes in algae populations.

RATIONALE

Surveys of wetlands offer the opportunity of obtaining firsthand knowledge of wetlands. This activity provides a simple means of conducting a survey within a classroom and could become a long-term study of the changes that occur within a wetland. This in turn could lead to practical applications in actual wetland studies.

STUDENT PRIOR KNOWLEDGE

Students should know how to use a microscope and a picture classification key for algae identification.

BACKGROUND

Algae is a primary producer in wetland communities. Changes in algal growth in seasonally flooded wetlands are influenced by water level fluctuations and the intake and leaching of nitrogen and phosphorus associated wetland vegetation.

All algae, including wetland algae, are grouped according to the habitats they occupy. Floating algae are called metaphyton. Algae suspended in open water column are called planktonic algae or phytoplankton. Algae that grow within bottom sediments, attached to bottom sediments or grow on plants are called periphytic algae or periphyton (Kantrud et al. 1989).

Aquatic insects or invertebrates feed on phytoplankton, bacteria, and organic detritus. These invertebrates are

important foods to waterfowl and their broods. (For additional background information see "Algae Survey" activity.)

MATERIALS

1. Aquarium or other large container with a tight screen top
2. Classification keys - Use the appendix from the Soil Conservation Service "Water Quality Indicators Guide: Surface Waters" and list of common freshwater algae in North Dakota wetlands found in Photocopy Booklet.
3. Graph paper
4. Petri dishes
5. Microscope
6. Pipettes or eye droppers
7. Cubic foot of wetland muck collected after heavy frost but before hard freeze
8. Wetland water 1 to 2 gallons
9. Classroom data table

PROCEDURE

1. The teacher or students can prepare the aquarium and collect wetland muck. Clip off tall foliage close to the top of muck and place into aquarium. Add 1 to 2 inches of water and let settle. Replace screen.
2. Review or practice algae count techniques using the microscope. (See "Algae Survey" activity.)
3. Have the students make predictions about changes in algae populations that will occur during the upcoming days.
4. Conduct initial identification and survey, and record results. Each member of the group should make a count and an average found for each group. Post group results on the classroom data table. Students can make their counts by pipetting (or use an eye dropper) some of the pond water into a petri dish and viewing the culture through a microscope.
5. Repeat observation of aquarium and algae count weekly.
6. Suggest possible reasons for the changes you observed.

EXTENSIONS

1. Add high nitrogen garden fertilizer to the water and observe changes in algae populations.
2. Diagram life-cycles observed.
3. Find supporting research for their explanations and observations.
4. Explore importance and uses of algae by using this technique to design another experiment applicable to biological studies.
5. Have students graph population changes.

EVALUATION

1. Make a comparison between the three types of algae found.
2. Student demonstration of use of classification key.
3. Based on the current data predict results for the next two weeks.
4. Diagram the layers of strata formed.

LITERATURE CITED / SUGGESTED READING

Kantrud, H.A., G.L. Krapu, and G.A. Swanson. 1989. Prairie basin wetland of the Dakotas: a community profile. U.S. Fish and Wildlife Service Biological Report 85(7.28). 116 pages.

Prescott, G.W. 1984. How to know the freshwater algae. Wm. C. Brown Company Publishers. 293 pages.

Terrell, Charles R. and Patricia Bytnar Perfetti. 1989. Water Quality Indicators Guide: Surface waters. U.S. Department of Agriculture, Soil Conservation Service. SCS-TP-161. 129 pages.

van der Valk, Arnold. 1989. Northern Prairie Wetlands. Iowa State University Press, Ames. 400 pages.

WETLANDS AND SOCIETY

During recent years, drastic changes have occurred in the nation's view of wetlands. In the past, wetlands were viewed as sources of disease and pestilence. The federal government encouraged wetland drainage and conversion to more useful purposes. Today, many people in the nation believe that wetlands have great value in their natural state. Because of the wide array of values that wetlands can provide, the benefits of wetland protection are mostly realized by the general public.

It is because of the general public's increased awareness and appreciation of the multiple values of wetlands, that many federal, state and private agencies have focused on wetland programs to preserve and enhance the nations wetland resource. The first substantial attention on a national level occurred in the early 1970's, when the federal government enacted the nation's first wetland regulatory program - Section 404 of the Clean Water Act. Initially, Section 404 focused its attention on costal wetlands. During the late 1970's, President Carter's administration made wetland protection an executive priority and a matter of national policy. The 1980's continued to focus national attention on wetland conservation and brought more federal regulation of the nation's wetlands, including expanded regulation by Section 404 of the Clean Water Act and additional regulation by Swampbuster of the 1985 Food Security Act. In addition to federal regulation of wetlands, many states have enacted wetland regulatory measures. The national focus on wetlands has continued when recently President Bush challenged the nation to achieve a goal of no-net-loss of wetlands in the United States. And, once again President Clinton has supported the interim goal of no-net-loss of wetlands.

FARMING WETLANDS

ABSTRACT

SUMMARY: Through a simulation activity, students will explore the diverse values of wetlands.

AGES: Grades 7 to 12

SUBJECT: Science, Agriculture Education, Math, Social Studies

DURATION: 100 minutes over two days

GROUP SIZE: whole class, in small groups of 3 to 4 persons

SETTING: indoor

SKILLS: Cooperative Learning, Computation, Estimating, Extrapolation, Graphing, Measuring

INTENDED LEARNING OUTCOMES

Students will explore the values of wetlands and farmlands. Students will measure economic benefits of different wetland uses. Students will be able to list several benefits of wetland areas.

RATIONALE

North Dakota is a rural farming state, many people in the state depend directly or indirectly upon agriculture for their income. This activity allows students to explore the issues of farming and wetlands. Students will benefit from parental involvement.

STUDENT PRIOR KNOWLEDGE

Students should understand that we all rely on agriculture. Students should understand other values of wetlands such as their importance for recreation, wildlife habitat, flood control, and water quality improvement.

BACKGROUND

North Dakota is a rural state that depends upon agriculture for its economic well being. Wetland soils are not only productive from a wildlife stand point, but are also productive for agricultural commodities. During drought, often times, wetlands are the only portion of a farmers field that is productive. However, the nation's waterfowl and other water birds as well as the state's resident wildlife depend upon North Dakota's wetlands for reproduction and migratory purposes. In addition, wetlands provide water retention during floods, improve water quality, and provide recreation for many residents. Because wetlands in North Dakota are important to both wildlife and agriculture there is a difference in opinion about how wetlands should be managed.

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (5-8) 1a,b,d; 2a,d,f,g; 4a,b; 5c,d,e
SCI (9-12) 1a; 2a,d,f,i; 4a,c,d; 5d,e
MATH (5-8) 1b; 2a,b; 4a,b; 7a,b; 8a,b; 10a
MATH (9-12) 1a,c; 4c; 7a,b; 8a,b; 10a
SOC (5-8) 7a; 11a; 13b
SOC (9-12) 7a,b,c; 11a,b; 13a,b

KEY VOCABULARY: acre, semipermanent wetland, seasonal wetland, tillable

MATERIALS

1. Student Page map of wetlands - two copies for each student
2. Graph paper - one copy for each group
3. Markers or colored pencils
4. A list of 3 to 4 crops to be studied, examples are provided below.

PROCEDURE

1. Review with the students all the values of wetlands, or view one of the two videos recommended in the "Suggested Viewing" section of this activity.
2. Hand out two Student Page maps to each student.
3. Define scale of your map (1 square = 1 acre).
4. Have the student group designate on the Student Page which wetlands are semipermanent or seasonal. Mark at least two wetlands as seasonal and one wetland as semipermanent.
5. Students should mark the seasonal and semipermanent wetlands with different colors or hatch marks.
6. Discuss the feasibility of cropping or haying a semipermanent and seasonal wetland. Discuss how weather will play an important role in determining the feasibility of cropping or haying a wetland. For example, during a wet spring and summer, a seasonal wetland will probably not be feasible for either haying or cropping. In years of average precipitation, a seasonal wetland will generally be feasible to hay. And, during dry periods a seasonal wetland could be feasible to crop or hay. A semipermanent wetland will generally be feasible to hay or crop only during extended drought periods. Depending upon the weather condition the group selects, your seasonal wetlands could either be hayed, cropped, left alone for other wetland values, or a combination of the above.
7. Each student group should agree upon a weather conditions (e.g., heavy or average precipitation, dry or drought conditions). Each group should decide how they will use each wetland (e.g., hayed, cropped, left alone) based on the weather conditions. Then assign one student in each group a different crop.

8. Have the students measure the total area of the field by counting the squares. The size of each wetland can be estimated by counting the total number of full squares, and adding the estimated portions of the partially covered squares. The total cropped area can be derived by subtracting from the total area the acres of non-cropped wetlands.
9. Assign each individual within each group one of the following crops and the average net profit of that crop per acre. Or, you can have the students research the net profit of crops in your area.

   Corn = $75.00/acre
   Wheat = $38.00/acre
   Seasonal Wetland Hay = $43.00/acre

10. Each student should calculate the net profit for their crop based on the group assigned weather condition and assigned wetland uses.
11. Have the group of students repeat the exercise but this time they should change the use of the wetlands. Therefore, the weather conditions, assigned wetland types and student crops will remain the same.
12. Each group should then combine this information, and construct a stacked bar graph of total net profit for both uses and all the crops. The graph should look similar to the example graph provided.
13. Upon completion of the bar graph each group should present to the class, their weather conditions, how their wetlands were used, why they choose these wetland uses, and how their choices affected the net profit of the field. The groups should continue to discuss what benefits are provide by the wetland uses selected, and who receives the benefits of the particular wetland uses.

Student Page Calculations

A - Net Profit per acre (Based on figures provided in step 9 for each crop.)
B - Total field acres = 551 acres
C - Total non-cropped acres = (Total acres of non-cropped wetlands.)
D - Total acres of hayed wetlands = (Total wetlands selected for hay use by the group.)
E - Total acres of cropped wetlands = (Total wetlands selected for crop use by the group.)
F - Total cropped acres = **[B - (C + D + E)]**
G - Field Net Profit - cropped land = **(F x A)**
H - Field Net Profit - hayed seasonal wetland = **(D x $43/acre)**
I - Field Net Profit - cropped wetlands = **(E x A)**
J - Total Net Field Profit = **(G + H + I)**

EXTENSIONS

1. Have each group select three different weather conditions for three cropping seasons. Have each group manipulate the wetland use, if they desire, based on each year's weather conditions. Have the group then repeat procedure steps 7, 10 and 11. They should then prepare a graph for each year and one for the average of the three years.
2. Invite a farming parent or guest speaker to talk with the class.
3. Check and compare the variation of crop prices from day to day or year to year.
4. Determine the average cost of an acre of land in your area, then determine what the field would cost, and how long the loan would take to pay off for cropping, not cropping, or haying the wetlands. You should consider pricing land in areas that produce small grain and sugar beets.

EVALUATION

1. Have students list the values of farmland and the values of wetland.
2. Ask students to form a conclusion, and describe in writing what they would do. Would they leave the wetland for other values, hay, crop, or put it to another use?
3. Ask the students for creative compromises for cropping wetlands in North Dakota.

SUGGESTED VIEWING

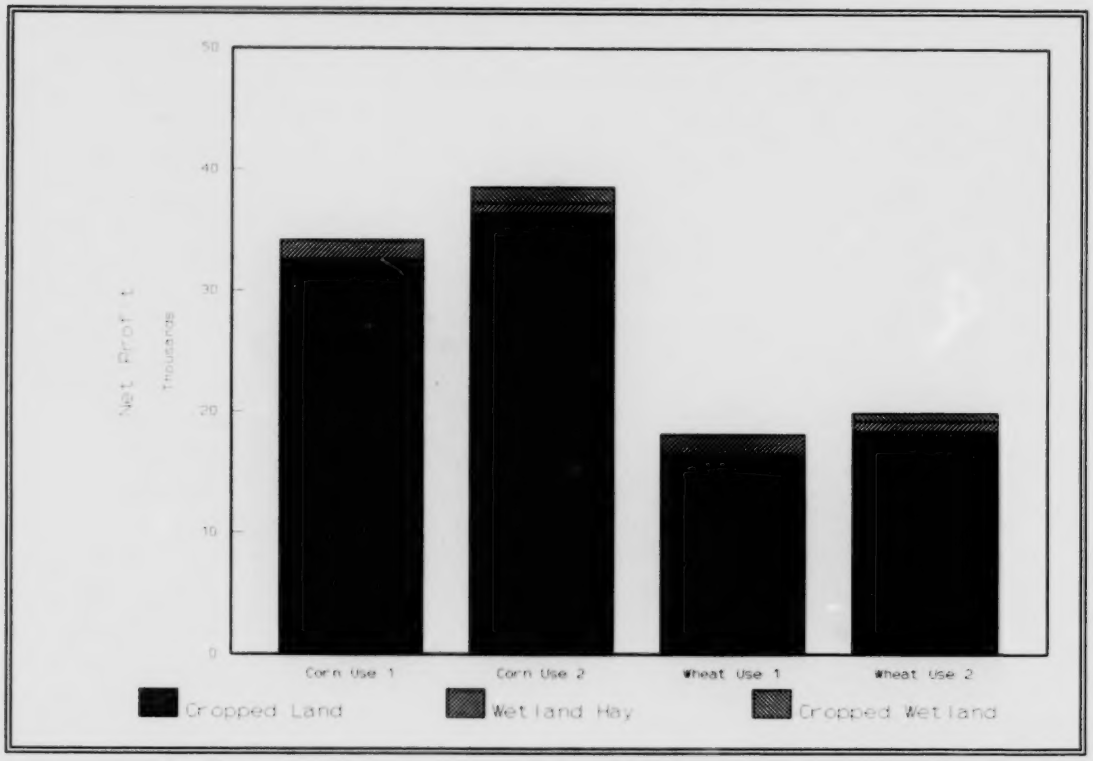
Video - "The Wealth in Wetlands" This video features five farmers in the United States who tell why the will keep their wetlands. Sponsored by the National Association of Conservation Districts, Successful Farming magazine, and other organizations. (23 minutes)

Video - "Prairie Potholes are for People" Parts 1 and 2 of this North Dakota State University Extension video production, discusses basic features of different types of North Dakota wetlands and the value wetlands provide to humans and animals. (25 minutes)

The above videos can be loaned from:

North Dakota Wetlands Institute
1501 N. 12th Street
Bismarck, ND 58501
phone # (701) 223-8332
fax # (701) 223-4645

EXAMPLE BAR GRAPH



Land Use	EXAMPLE FIELD NET PROFIT			
	Corn		Wheat	
	Use #1	Use #2	Use #1	Use #2
Cropped Land	$32,625	$36,375	$16,530	$18,430
Hayed Seasonal Wetland	$ 1,591	$ 817	$1,591	$ 817
Cropped Wetland	None	$ 1,350	None	$ 684
Total Profit	$34,216	$38,542	$18,121	$19,931

Weather Condition = Average precipitation

Total Field acres = 551

Use #1

Semipermanent wetlands not hayed or cropped = 29 acres
Seasonal wetlands all hayed = 37 acres
Cropped Land = 501 acres

Use #2

Semipermanent wetlands not hayed or cropped = 29 acres
Seasonal wetlands hayed = 19 acres
Seasonal wetlands cropped = 18 acres
Cropped Land = 501 acres

BEST COPY AVAILABLE

WETLAND DEBATE

ABSTRACT

SUMMARY:
Through debate and role playing, students will become informed about different perspectives surrounding wetland issues.

AGES: Grades 5 to 12

SUBJECT: Science, Social Studies and Language Arts

DURATION: 60 to 120 minutes over three class periods

GROUP SIZE: whole class, or in groups of 2 to 3 individuals

SETTING: indoors

SKILLS: Analysis, Communication, Critical Thinking, Debate, Discussion, Listening

NORTH DAKOTA CURRICULUM REFERENCE:
SCI (5-8) 1b,d; 4a,b; 5b,c,d,e;
SCI (9-12) 1a; 4a,b,c,d; 5b,c,d,e
SOC (5-8) 1d; 2b; 4b; 7a; 11a; 13a,b; 14a
SOC (9-12) 1a; 4a,b; 11a,b; 13a,b; 14a
LANG (5-8) 3a,c,d,e,f,g,k; 4a,e,g,j
LANG (9-12) 3a,c,d,e,i; 4a,c,e,f

INTENDED LEARNING OUTCOMES

Students will learn the value of wetlands from different perspectives. They will also learn to formulate and evaluate alternatives to wetland land use conflicts.

RATIONALE

Today's children will be tomorrow's adults. This role playing activity allows students to explore some of the different perspectives involved in wetlands issues and the opportunity to discuss different points of view.

STUDENT PRIOR KNOWLEDGE

No prior knowledge is needed.

BACKGROUND

Use of the land by our state residents affects wildlife and wetland habitat, both positively and negatively. What we do with the land is a reflection of our priorities and values. When observing wetland issues in North Dakota there is a broad perspective of priorities and values. Some people believe that natural areas are intended for use by man. Others believe natural areas should be left alone without regard for human needs. Still others believe a balance can be struck between wetland preservation and economic development. Generally, there too is a broad difference in opinions of where the "balance" is struck.

The purpose of this activity is to get students to witness firsthand the differences in opinions regarding use of a wetland area.

KEY VOCABULARY: debate, wetland

MATERIALS

1. Community member identity cards with description (index card and marker)
2. Paper
3. Pencil

PROCEDURE

1. To help familiarize students with wetlands, their values and potential conflicts associated with wetland conservation have the class view the video "Prairie Potholes are for People," produced by North Dakota State University Extension.
2. Tell students the situation - read the scenario to the class.

   WETLAND SITUATION

   You are a member of a community next to a large wetland area. An industry wants to build a factory on the wetland area. Commission members need to decide what will be done with the factory and wetland area. Some community members feel the wetland should be filled in and used for the new factory, and others would like it left alone. A few are undecided on what to do. Three commissioners have called a community meeting to listen to the viewpoints of community citizens. After a discussion and debate, the commissioners will summarize their viewpoint and make recommendations for solutions to the situation.
3. Appoint or ask for three volunteers to act as commissioners.
4. Give identity cards to all members of the class. Or students could be placed into groups of 2 or 3, to represent one community member.

   COMMUNITY MEMBERS - IDENTITY CARDS

   a. Commissioner I - Undecided
   b. Commissioner II - Undecided
   c. Commissioner III - Undecided

OTHER COMMUNITY MEMBERS- could include any of the following.

1. Land developer
2. Store owner
3. Doctor
4. Nurse
5. Realtor
6. Rancher
7. Gun Salesman
8. Hardware salesperson
9. Grocery store owner
10. Clothing store owner
11. Lawyer
12. Hunter
13. Wildlife manager
14. Restaurant owner
15. Furniture salesman
16. Hotel operator
17. Homemaker
18. Sheriff
19. Minister
20. Banker
21. News reporter
22. Construction worker
23. Chamber of Commerce
24. Grain Elevator manager
25. Trucker
26. College student
27. Principal

3 Farmers (grains, potatoes, dairy)
2 Teachers (elementary and college professor)

5. Each community member should write up 3 to 5 arguments supporting their point of view about the situation. Some points of view may include: (1) support for filling in the wetland for community development, jobs and industrial sites, (2) support for leaving the wetland because of its value for wildlife, flood control, water quality improvement and that the community was built here because of the beauty and usefulness of the wetland therefore it should be left alone. Or, some community members could offer alternatives to building the factory on the wetland. They may suggest a different location that doesn't have a wetland located there.
6. The community members should write a brief description of themselves, and should study their arguments and viewpoints to prepare for debate. You may have the students or group conduct research into their perspective and support it through use of scientific evidence. Some students may wish to look into current laws regulating wetlands. (For a brief description of laws, see "A Guide to Wetlands in North Dakota" found in the North Dakota WET (Water Education for Teachers) Reference Binder). (This out-of-class research may take a few days for students to prepare.)
7. Each community member must present their views to the commissioners on the issue and tell why they believe as

they do. Commissioners should question them at this time.

8. The next day, have a class discussion on the issue, and list options available. Students should discuss the pros and cons of each option. ALL members should vote on whether to drain and develop the wetland, preserve and maintain it, or come up with a third alternative, such as moving the factory to a new location.

DEBATE OVERVIEW

Have students (community members) present and provide evidence to the Commissioners of the values of wetlands to people.

a. reduce siltation
b. improve water quality
c. retain flood water
d. recharge groundwater
e. uses for haying and grazing
f. provide habitat for wildlife
g. productive cropland during drought

Have students (community members) present and provide evidence to the Commissioners of the benefits the factory will provide to the community.

a. jobs
b. economic development
c. improved business atmosphere
d. increase tax base

Have students (community members) propose alternative solutions to filling the wetland to the Commissioners.

The students (community members) should provide both factual and emotionally based testimony.

The Commission members should ask community members questions about their testimony and information resources. This will aid in distinguishing between factual and emotional testimony.

The Commission members should discuss alternative proposals or solutions presented by the community members.

EXTENSIONS

1. Discuss the effects of natural and human disaster.
2. Make a model or mural of your final decision.
3. Have the students research a local wetland issue.
4. The teacher may wish to bring guest speakers to talk to the class about their perspectives on wetland issues in North Dakota. Some of the perspective could include: agriculture, wetland conservation, economic development, and water interest perspectives.

EVALUATION

1. Have the students write out the positive and negative aspects of the wetland issue.
2. Have the students put together a video of why wetlands are important.

SUGGESTED READING/VIEWING

Video - "Prairie Potholes are for People" (387-8) (35 minutes)
This video can be obtained by writing:

NDSU Extension Service		N.D. Wetlands Institute
Media Library	OR	1501 N. 12th Street
Box 5655, Morrill Hall		Bismarck, ND 58501
Fargo, ND 58105-5655		ph. # (701) 223-8332

"A Guide to Wetlands of North Dakota" 1992. North Dakota Wetlands Institute, Bismarck, ND (A copy is inserted in the North Dakota WET Reference binder.)

"North Dakota Wetlands Discovery Guide" 1994. Background information from the "Wetland Functions" section activities will provide additional information.

Wetland Unit Review Activities

WETLANDS JEOPARDY

ABSTRACT

SUMMARY:
Through a fun and familiar format of the popular game "Jeopardy," students will be able to review what they have learned about North Dakota wetlands.

AGES: Grades 4 to 8

SUBJECT: Science, Social Studies, and Geography

DURATION: 20 to 40 minutes

GROUP SIZE: whole class, in small groups

SETTING: indoors

SKILLS: Communication, Identification, Listening, Recognition, Small Group Work

KEY VOCABULARY: see specific activities taught

INTENDED LEARNING OUTCOMES

The students will review what they have learned about North Dakota wetland terminology, location, functions, and the wetland community.

RATIONALE

Students are often motivated to learn and cooperate with others when engaged in an interactive activity. This activity allows students to pool their group knowledge on wetlands in a fun and exciting manner.

MATERIALS

1. Overhead projector
2. Screen
3. Wetlands Jeopardy questions (See Photocopy Booklet), photocopied on acetate
4. One 8-1/2" x 11" clear slide protector for a cover sheet with paper inserted into each pocket to hide the questions, or other cards to cover individual questions
5. Answer Sheet on a following page
6. Clock

PROCEDURE

1. Divide the students into four teams or play as individuals.
2. Review with the students how to play Jeopardy, and discuss rules:
   a. One team member will be allowed to raise their hand and respond to the question. The team has ten seconds to respond to the question. If they are correct they may choose the next category and question.

b. If the first team gives an incorrect answer, the next team to raise their hands gets an opportunity to respond.
c. A correct answer will be given the respective score (e.g., 10, 20, 30 or 40). However, an incorrect answer will be deducted from the score.
d. The team to score the most points wins.

3. Put the overhead sheet on and be sure to cover the questions with the slide sheet (which has cardboard inserted to cover the questions).
4. Let the first team pick a category.
5. Keep track of the points, 10, 20, etc.

EXTENSIONS

1. Let the students make up their own Jeopardy game questions about North Dakota wetlands.
2. The teacher could also create his or her own questions that review a specific activity or wetland unit.

WETLAND JEOPARDY -- ANSWER SHEET

Wetland Terms	Functions	Wetland Community	Potpourri
Three characteristics that define what is a wetland. WHAT IS WATER, SOIL, AND PLANTS?	Wetlands help improve the quality of this resource that is used by all living creatures. WHAT IS WATER?	A common wetland plant with a brown top that is eaten by muskrats. WHAT ARE CATTAILS?	Type of soil that loves water. WHAT IS CLAY?
Another name for North Dakota wetlands. WHAT ARE PRAIRIE POTHOLE?	Wetlands help protect humans and property against this kind of natural disaster. WHAT ARE FLOODS?	Generic name for insects without backbones found in wetlands. WHAT ARE AQUATIC INVERTEBRATES?	A wetland grass that is excellent for hay production. WHAT IS WHITETOP?
Geological process that formed North Dakota's prairie wetland landscape. WHAT IS GLACIATION?	Wetlands provide critical habitat for these migratory birds. WHAT ARE DUCKS, GEESE, SWANS OR CRANES?	Three factors limiting survival of migratory bird populations. WHAT IS WETLAND DRAINAGE, SEVERE WEATHER OR DROUGHT, POLLUTION, ILLEGAL HUNTING, PREDATION, OR DISEASE?	The type of wetlands commonly used by muskrats. WHAT ARE SEMIPERMANENT OR PERMANENT WETLANDS?
Term for the geographical area of North Dakota where the largest number and area of wetlands is found. WHAT IS THE GLACIATED PLAINS?	Wetland plants help sift these substances out of the water. WHAT IS SEDIMENT?	An animal uses this coloration or behavioral techniques to enhance their survival. WHAT IS CAMOUFLAGE?	The name of the area from which wetlands receive its water supply. WHAT IS A WATERSHED?

WETLAND HOP

ABSTRACT

SUMMARY:
Playing this board game will help students review what they have learned about North Dakota wetlands.

AGES: Grades 3 to 6
Can be adapted for younger students.

SUBJECT: Science, Social Studies and Geography

DURATION: 30 to 40 minutes

GROUP SIZE: whole class, in small groups of 3 to 4 students

SETTING: indoors

SKILLS: Communication, Identification, Listening, Questioning, Reading, Research, Small Group Work, Verifying

INTENDED LEARNING OUTCOMES

The students will review knowledge about North Dakota wetlands through a cooperative learning experience.

RATIONALE

To allow students to pool their diverse knowledge of North Dakota wetlands.

MATERIALS

1. A copy of the Wetland Hop game board (See Photocopy Booklet), or more copies depending upon the number of teams playing. The 8.5 x 11 inch paper game board can be enlarged by 130% to a 11 x 17 inch paper. You may wish to back the game board with tag board for sturdiness.
2. In advance, prepare the game cards with sample question on 3 x 5 index cards. Sample questions are included.
3. Game board markers for each team such as coins, paper clips, beans or other small objects.

PROCEDURE

1. Each team may include 1 player, but should not exceed 3 players.
2. All teams begin at "A". The team to the left reads the questions to the team playing.
3. Teams may talk among themselves for a few seconds before coming up with an answer.
4. If the playing team has the correct answer, they then move forward and receive another question until they give an incorrect answer. Students may challenge an answer if supported by research, if correct the

challenging team automatically becomes the playing team.

5. If the playing team has an incorrect answer, they remain where they are, and the next team begins their play.
6. The first team to "HOP" into the "PRAIRIE POTHOLE" wins.

SAMPLE QUESTIONS

To begin, use the sample questions below. You may wish to develop you own questions specific to the wetland unit or activity taught. Or, as your students gain more experience and knowledge you may wish them to add their own questions. To develop questions, you may consider using guides, magazines, and the library for reference materials. Make a few cards that say: Advance two spaces! Go back one space. Lose a turn. Take another turn.

a. Approximately how many years ago did the glaciers retreat from North Dakota? 10,000 to 13,000

b. What migratory birds with webbed feet rely on prairie potholes for migration, food, nesting and rearing their young? DUCKS or GEESE

c. What insect can be found "walking" on water in most wetlands? WATER STRIDER

d. What amphibian is found "hopping" around a wetland and burrows in the mud in the winter? FROG OR TOAD

e. What would you call the large moving piece of ice that covered North Dakota thousands of years ago and is responsible for creating our prairie potholes? GLACIER

f. The place where a plant or animal's food, water, shelter or cover, and space are naturally found? HABITAT

g. A complete "suit" of feathers worn by a bird is what? PLUMAGE

h. What plant has a fuzzy, tail-like top and is found in a wetland, and blackbirds build their nest in them? CATTAILS

i. What song birds come from the south each spring and sing a noisy "O-ka-lee!? RED-WINGED BLACKBIRDS

j. What is the name of the plant with large leaves and yellow flowers that floats on the surface of the water? YELLOW WATER LILY

k. What animal eats and builds a dome shaped house out of cattails? MUSKRAT

l. What do you call a young fuzzy duck? DUCKLING

m. True or False? A female moose has antlers? FALSE

n. What do you call a immature dragonfly? NYMPH

o. What animal made the tracks found on the map between points "G" and "F"? DUCK or GOOSE

p. Name the wetlands plant that produces a cereal grain that is a favorite of both humans and ducks? WILD RICE

q. What physiographic region of North Dakota has the largest number of semipermanent wetlands? MISSOURI COTEAU

s. From what precipitation sources do North Dakota wetland receive their water? SNOW MELT AND RAIN

t. During years of normal run-off and precipitation, which prairie wetland type will hold water until early June? TEMPORARY WETLANDS

u. During years of normal run-off and precipitation, which prairie wetland type will hold water until mid-July? SEASONAL WETLANDS

v. Except for years of extended below normal run-off and precipitation, which prairie wetland type will hold water year around? SEMIPERMANENT WETLANDS

w. What animal made the tracks found between "D" and "F"? MOOSE

x. What geologic activity formed the depressions where prairie wetlands are found? BLOCKS OF GLACIAL ICE

y. Name two natural functions of wetlands? FLOOD CONTROL, WATER QUALITY IMPROVEMENT, WILDLIFE HABITAT, GROUNDWATER RECHARGE

z. What factors affect the rate of erosion? TYPE OF SOIL MATERIAL, SEVERE WEATHER EVENT, PLANT COVER ON SOIL, AND TOPOGRAPHY

aa. What animal tracks are found between points "L" and "M"? BEAVER TRACKS

bb. What factors damage water and wetland resources? POLLUTION FROM AGRICULTURAL CHEMICALS, LEAKING UNDERGROUND TANKS OF PETROLEUM OR SEWAGE

cc. How does non-point source pollution enter a wetland? PRECIPITATION RUN-OFF

dd. What water quality parameters affects aquatic life? pH, DISSOLVED OXYGEN, AND TEMPERATURE

ee. What are the four components of habitat? FOOD, WATER, SHELTER, AND SPACE

ff. The name of the area that contains all the habitat components of an animal. TERRITORIES

EXTENSIONS

1. You may want to have a self-stick note with a letter from the word "WETLANDS" attached to some of the cards. If the team answers the question correctly they get to keep the letter. The first team to spell "wetland" or reach the wetland on the game board is the winner.
2. Have the students divide into teams or individually make up four or five questions for the game. Assign student groups a topic area about wetlands, student groups could then develop questions based on research they have done.
3. Make a larger version of game board outdoors with chalk and participants will become the game pieces.

GLOSSARY OF TERMS

This Glossary was complied from a variety of sources. We would like to thank the following organizations for their contributions:

[a]Reprinted with permission of the Ohio Cooperative Extension Service (Ohio State University)

[b]Reprinted with the permission of Macmillan College Publishing Company from THE NATURE AND PROPERTY OF SOILS, 10/e by Nyle C. Brady. Copyright ©1990 by Macmillan College Publishing Company, Inc.

[c]Reproduced with permission of the publisher: from Hands-On Nature, Vermont Institute of Natural Science, RR 2, Box 523, Woodstock, Vermont, 05091, c 1986

[d]Virginia's State Parks-Your Backyard Classrooms, Chesapeake Edition (Virginia Department of Conservation and Recreation)

[e]Adapted with permission from Project WILD ©1987, 1992 Western Regional Environmental Education Council

[f]Reprinted with permission, American Forest Foundation, ©1993, Project Learning Tree Environmental Education Activity Guide Pre K-8. The complete Activity Guide can be obtained by attending a PLT workshop. For more information call the National PLT office at 202/463-2462.

[g]Discover Wetlands-A Curriculum Guide (Washington State Department of Ecology)

[h]Soil Conservation in North Dakota (Project WILD - North Dakota).

Absorption[b]	Movement of water and ions into a plant root as a result of metabolic processes by the root.
Acre	A unit of measurement of land. It is equal to the area of land inside a square that is about 209 feet on each side (43,560 square feet).
Acre-foot	The amount of water that covers one acre of surface to a depth of one foot (12 inches). It equals 329,825 gallons.
Adaptation	A physical structure or a behavior that aids a plant or animal in coping with its environment. Change to meet changing conditions is adaptation or the process of making adjustments to the environment.
Algae[c]	Simple one-celled or many-celled plants, capable of photosynthesis; usually aquatic.
Amphibian[c]	Members of a class of cold-blooded vertebrate animals that includes frogs, toads, and salamanders. They also lay eggs in the water, where they hatch into gill-breathing larvae and metamorphose into terrestrial adults that usually have lungs and can breath through moist glandular skin.
Anatomy	The structure or parts of a plant or animal.
Animal community	Animals of various species living within a certain habitat, each occupying a specific position in this particular environment; directly parallel and related to plant communities.

Atmospheric Deposition	Particles suspended in the air that fall on to the land with precipitation.
Aquatic[e]	Growing in, living in, frequenting, or pertaining to water.
Basal	Growing from the base of the plant where the plant stem intersects with the soil.
Basin	A shallow land surface depression where run-off and precipitation collect during years of normal weather conditions.
Biodegradable[a]	Products which are capable of being broken down by bacteria into simpler molecules. Most organic waste, such as food remains and paper, are biodegradable.
Bog[e]	A wetland formed where low oxygen levels and soil temperature cause incomplete decomposition and limited drainage, in an accumulation of fibrous peat or dominated by sphagnum mosses. (There is only one known sphagnum bog in North Dakota. It is found in Bottineau County.)
Buffer Zone	Strips of natural plant growth along a wetland, river or stream banks which help to prevent soil erosion from plowed fields or developed land.
Camouflage	Technique, color, or shape that helps an organism hide from its predators, or prey.
Capillary Action	The upward movement of water through a plant.
Clay	A fine-grained material that expands when wet.
Community[e]	A group of plant and animal species living together in a habitat. An association of organisms (plant and animal) each occupying a certain position or ecological niche, inhabiting a common environment, and interacting with each other. All the plants and animals in a particular habitat that are bound together by food chains and other interrelationships.
Compaction	A process of forcing materials closer together and with small or few air pockets between the particles.
Condensation[e]	The process of a substance changing from a gas to a liquid, usually as a result of cooling.
Conductivity	A measure of the ability of a material to conduct an electrical charge.
Consumer	An organism which cannot produce its own food, and which must eat or live off of other organisms in order to obtain energy to live.

Contaminants	Something that causes an impure substance by contact or mixture.
Control	(In an experiment) - The portion of the experiment that provides a reference to analyze the results of your experimental variable(s).
Cover	The vegetation, debris, and irregularities of the land that provide concealment, sleeping, feeding and breeding areas for wildlife.
Dead-ice moraine	The most rugged kind of topography that was formed by glaciers in North Dakota.
Debate	An organized discussion of opposing points about a particular issue.
Depression	An area that is shallower than its surroundings.
Detritus	The loose particles that have been formed by disintegrated matter.
Dichotomous Key	A guide to identification of plants or animals consisting of a series of pairs of questions or descriptions.
Dissolved oxygen[c]	Oxygen dissolved in water.
Distillation	A process of heating used to separate a portion of a complex substance.
Diversity	The number of distinct species in a community or ecosystem. The many likenesses and differences occurring among living and non-living things.
Draining	The act of removing water from the land surface.
Drainage	The ability to drain off water.
Ecosystem[c]	A natural unit that includes living and nonliving parts interacting to produce a stable system in which the exchange of materials between the living and nonliving parts follow a closed path. All living things and their environment in an area of any size, with all linked together by energy and nutrient flow.
Elevation	The number of feet above or below mean sea level.
Endangered species	Organisms that are in danger of extinction throughout all or a significant portion of their range.
Erosion[c]	The removal or wearing away of soil or rock by water, wind, or other forces or processes.
Eutrophication[b]	A means of aging of lakes whereby aquatic plants are abundant and waters are deficient in oxygen. The process is usually accelerated by enrichment of waters with surface runoff containing nitrogen and phosphorus.

Evaporation	The process of a substance changing from a liquid to a gas by exposure to the air and/or heat.
Evapotranspiration	The process of transferring moisture from the earth to the atmosphere by evaporation of water and transpiration from plants.
Fauna	The animal life of a given area or period.
Fen	A wetland fed year-round by nutrient rich water and underlain by peat. Prevailing vegetation varies from low grassy plants to tall shrubs. They are usually found on sloping river valleys.
Filter	To remove by passing through.
Filtration Area	A zone that removes substances as they pass through the area.
Food Chain[c]	The transfer of food energy in sequence from plants to animals that eat plants to animals that eat other animals. A group of animals and plants in which energy, in the form of food, flows.
Food Web[c]	An interlocking pattern of food chains.
Frequency Distribution	The number of data items falling within each class.
Fresh Water[c]	Clean, unpolluted water without salinity.
Freshwater Marsh[d]	An area dominated by herbaceous plants with roots in soil covered part or all of the time by fresh water and leaves held above the water.
Geology	The study of the physical nature and history of the earth.
Glacial Till	A mixture of materials deposited directly glacial ice and consisting of clay, sand, gravel, and boulders intermingled.
Glaciated Plains	Or, drift plain, is a North Dakota physiographic region with rolling glaciated landscape. Eighty percent is gently sloping with local relief of less than 100 feet.
Glacier	A huge sheet of ice that "flows" inches, sometimes feet, a day.
Groundwater	Water, beneath the earth's surface between saturated soils and rock, that supplies wells and springs.
Habitat[c]	The arrangement of food, water, shelter or cover, and space suitable to animals' needs. It is the "life range" which must include food and water, as well as escape cover, winter cover, and cover to rear young.

Habitat Components	Food, water, shelter, and space
Hach Kit	A kit use to test various water quality parameters.
Heavy Metals[g]	Pollutants such as arsenic, copper and lead which may be toxic to aquatic organisms.
Hydric Soil	Water-loving soil.
Hydrophytic	A plant that grows in or is adapted to an aquatic or very wet environment.
Ice Age	A series of cold periods of extensive glaciation alternating with periods of warmth.
Insecticide	A pesticide to control insect populations.
Indicators	A parameter that points to a situation.
Infiltration[b]	The downward entry of water into the soil.
Invertebrate[c]	An animal that has no backbone or internal skeleton, but uses some other form of support such as a shell or ex-skeleton.
Lake	A deepwater aquatic environment.
Land Form	A type of land formed by geological processes.
Landscape	The overall view of the land.
Life Cycle[e]	The continuous sequence of changes undergone by an organism from one primary form to the development of the same form again.
Limiting factors[e]	Influences in the life history of any animal, population of animals, or species (e.g., food, water, shelter, space, disease, predation, climatic conditions, pollution, poaching, and accidents). When one or more of these exceeds or does not meet minimum limits of tolerance of that animal, population of animals or species, it then becomes a limiting factor; it then directly affects the well-being of that animal and may result in the animal or animals' death.
Marsh	Wetland characterized by grasses and herbs (non-woody plants).
Metaphor	Figure of speech where a term is transferred from its ordinary meanings to a meaning used for comparison or analogy.
Metaphyton	Floating algae.

Migration	Any movement between two areas and in a response of an animal population to changes in environmental conditions.
Missouri Coteau	A North Dakota physiographic region characterized by hummocky, glaciated irregular plains. Gently sloping area and local relief ranges from 300 to 500 feet.
Missouri Coteau Slope	A North Dakota physiographic region of rolling to hilly plains east of the Missouri River that have both erosional and glacial landforms. Gently sloping area with local relief ranges form 100 to 300 feet.
Niche	The role played by an organism in a biological community; its food, preference, requirements for shelter, specific behavior, and timing of activities.
Nitrates	A nutrient utilized by plants.
Nonpoint source pollution[d]	A source of water pollution which is not readily identifiable, for example from farms or dumping from boats
Nutrients	Elements or compounds essential to life, such as carbon, oxygen, nitrogen, phosphorus and many others.
Organic Matter	Material derived from living organisms.
Outflow	Removal of water through a shallow channel.
Parent Material	The weathered material or minerals from which soils are developed.
Particles	A piece or part.
Percolation[h]	The downward movement of water in soil.
Periphyton	Organisms clinging to stones, plants, on the bottom or lurking in vegetation.
Permeability[h]	The quality of soil that allows air or water to move through it.
Permanent Wetland	An area with a well defined basin which characteristically holds water throughout the year. Permanent wetlands go dry only after successive years of drought.
Pesticide[f]	An agent used to control undesirable organisms. The can be an insecticide for insect control, a herbicide for weed control, a fungicide for control of fungal plant diseases, or a rodenticide for killing rats and mice. Some pesticides can contaminate water, air, or soil, or accumulate in the tissues of living organisms, and should therefore be used carefully.

pH	A measure of acidity. A pH of 7 is neutral; lower values are acidic; higher values alkaline or basic.
Phytoplankton	Algae suspended in open water column.
Physiographic	A physical feature of natural land forms of a region.
Pollutants	The release of substances or energy into the environment by man in quantities that damage either his or her health or resources.
Pollution[a]	The results of harmful chemicals or waste material discharged into the water, atmosphere or land.
Pond	A small, shallow body of water.
Pooling	A low place where water collects.
Population[e]	The number of a particular species in defined area.
Pothole	A small often round pond.
Precipitation[h]	Rain, snow and other forms of water that fall to the earth.
Predator[c]	An animal that kills and eats other animals.
Prey	A creature that is caught, killed and eaten by another animal.
Primary Consumer	An animal that eats plants.
Producer[c]	Green plants which are able to manufacture food from simple organic substances and energy (sun).
Protection	Safe from harm.
Puddle	A small pool of water.
Ratio	A relative size of two quantities.
Region	Refers to the Prairie Pothole Region, an area of prairie that contains a large density of wetlands.
Reptile[c]	A member of the class of cold-blooded vertebrate animals including lizards, snakes, turtles, characterized by dry, scaly skin and eggs suited for development on land with membranes and shells to protect the embryo.
Resident Wildlife	Animals which are residents to an area on a year-round basis, as opposed to migratory.

Riparian[c]	Located or living along or near a stream, river, or body of water.
Run-off[h]	Water that flows off land into wetlands, lakes, streams and other water bodies.
Saline	Pertaining to salty conditions.
Scars	A mark left on the landscape by geological processes.
Seasonal wetland	A depression which holds water in normal years of spring run-off until mid-July. In years of normal run-off and precipitation, seasonal wetlands are probably not tilled but are used for hayland and pasture. In low run-off, dry years, these areas can be tilled for crop production, but commonly re-flood with frequent or heavy summer or fall rains.
Secondary Consumer[c]	An animal that eats other animals.
Sediment	Particles of soil and other organic matter that are deposited in the air or water.
Sedimentation	A process by which soils are moved, settle out, and deposited.
Semipermanent wetland	Is a well-defined depression or basin which holds water in normal years throughout the summer. Semipermanent wetlands generally go dry only in years of below normal run-off and precipitation. Freshwater semipermanent wetlands are commonly referred to as cattail sloughs. Saline semipermanent wetlands are also commonly found in North Dakota.
Shallow	Lacking depth.
Silt	A collection of fine soil particles.
Slope	The degree of deviation of a surface from horizontal.
Slough	A stagnant marsh or bog.
Soil[h]	A naturally occurring mixture of minerals, organic matter, water, and air which has a definite structure and composition and forms on the surface of the land.
Species	A population of individuals that are more or less alike, and that are able to breed and produce fertile offspring under natural conditions.
Stomata	Plural of stoma, which is a small pore in the epidermis of a leaf or stem through which gas and water vapor pass.
Succession[c]	The orderly, gradual, and continuous replacement of one plant or animal by another.

Surface Tension[c]	A property of liquid in which the surface layer has a stretched, elastic character that offers some resistance to penetration.
Survey	To investigate in a comprehensive manner.
Swamp	Wetland dominated by trees and shrubs; a forested wetland.
Temperature	The hotness or coldness of an environment.
Temporary Wetland	A shallow depressional area which holds water or is waterlogged from spring run-off until early June. In years of high run-off or heavy spring rain, these areas may not dry out until mid-July. These areas frequently re-flood with heavy summer and fall rains.
Territory[f]	An area used for breeding, feeding, or both, which is defended by an animal against others of the same species.
Threatened	A native species or subspecies likely to become endangered in the foreseeable future.
Tillable	The ability to prepare the soil for production of a crop.
Tolerance level	The capacity of an organism to with stand amounts without adverse effects.
Topography[g]	The physical features of a place or region.
Transpiration	Release of water vapor from the aerial parts of a plant, primarily through the stomata.
Turbidity	Having sediments or foreign particles stirred up or suspended in water.
Upland Habitat	The non-aquatic or higher portions of the land.
Vascular System	A group of vessels for the transmission of plant or animal fluids.
Water Bird	A bird whose life cycle is dependant upon water for completion.
Water Cycle	The endless circulation of water from the oceans to the atmosphere to the rivers and groundwater and back to the oceans again.
Waterfowl[g]	A group of birds that uses freshwater areas, such as ducks and geese.
Water Quality	How usable the water is for its inhabitants or user.
Watershed	The region into which a river, river system or body of water drains.

Water Table[b]	The upper surface of ground water or that level below which soil is saturated with water.
Wetland	A low lying area that collects water or intersects the water table, or an area of transition between upland and permanent open water. A scientific definition is an area that has a predominance of hydric (wet) soils and that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances does support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions.
Xylem	A vascular tissue that transports water and dissolved minerals upward through the plant body.

APPENDICES

APPENDIX A - NORTH DAKOTA CURRICULUM FRAMEWORKS

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LANGUAGE ARTS FRAMEWORKS

CONTENT OUTCOMES AND STUDENT PERFORMANCE STANDARDS

1. THE STUDENT READS TO UNDERSTAND WRITTEN MATERIALS.
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:

a. find pleasure and satisfaction in reading.
b. use prior knowledge to employ a variety of strategies while reading.
c. apply reading skills and strategies daily for a variety of purposes.
d. increase vocabulary.
g. integrate reading with speaking, writing, listening, and viewing.

By the end of grade 8
The student demonstrates the ability to:

a. apply reading skills and strategies for a variety of purposes.
b. recognize and adjust to different forms of writing.
c. apply strategies for selecting, learning and extending vocabulary.
e. evaluate and organize information from a number of resources and personal observations.
f. interpret written materials using background knowledge, literary elements, inferences, and structures.
h. integrate reading with speaking, listening, viewing, and writing experiences.
j. learn about self and others through reflection of literature.

By the end of grade 12 or at exit
The student demonstrates the ability to:

c. analyze the use of figurative language (metaphor, simile, personification, etc.).
e. develop and apply an increasingly sophisticated vocabulary.
h. use resource materials to find, evaluate, and synthesize information.

2. **THE STUDENT COMMUNICATES EFFECTIVELY THROUGH WRITING.**
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
a. find pleasure and satisfaction in writing.
b. use writing as a tool for learning and thinking.
e. use various resources during the writing process.
f. integrate writing with speaking, listening, viewing, and reading experiences across the curriculum.

By the end of grade 8
The student demonstrates the ability to:
a. use writing as a tool for learning and thinking.
b. integrate writing with speaking, listening, viewing, and reading experiences across the curriculum.
e. use a variety of resources to gather information for writing.

By the end of grade 12 or at exit
The student demonstrates the ability to:
a. use writing as a tool for learning and thinking.
f. expand one's vocabulary through writing.

3. **THE STUDENT LISTENS ACTIVELY TO FACILITATE COMMUNICATION.**
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
a. integrate listening daily with reading, writing, speaking, and viewing experiences across the curriculum.
b. listen for a variety of purposes using varied resources.
c. extend knowledge and develop vocabulary through listening experiences.

By the end of grade 8
The student demonstrates the ability to:
a. listen actively.
c. expand vocabulary through listening.
d. predict and infer meaning from an oral message.
e. summarize an oral message.
f. listen for a variety of purposes.
g. note relevant information while listening.
j. seek meaning of figurative language.
k. recognize stereotypes, biases, and propaganda techniques.

By the end of grade 12 or exit

The student demonstrates the ability to:

a. listen attentively and empathetically.
c. expand vocabulary.
d. distinguish between information and persuasion.
e. interpret and evaluate purpose and content (bias, doublespeak, propaganda, emotional appeals, fallacy, statistics, etc.).
i. participate actively in communication situations.

4. THE STUDENT COMMUNICATES EFFECTIVELY THROUGH SPEAKING.

Benchmarks/Performance Standards:

By the end of grade 4

The student demonstrates the ability to:

a. integrate speaking with reading, writing, listening, and viewing.

By the end of grade 8

The student demonstrates the ability to:

a. speak clearly and expressively about ideas and concerns.
e. integrate speaking with writing, listening, viewing, and reading experiences.
g. participate in small or whole-group oral language activities.
j. develop effective discussion skills.

By the end of grade 12 or at exit

The student demonstrates the ability to:

a. analyze the speaking, situation, formal (public speaking, discussion, debate, oral interpretation, etc.) and informal.
c. gather supporting materials and test them for credibility, reasoning, and evidence.
e. employ effective delivery techniques (rate, volume, tone, articulation, posture, gesture, eye contact, etc.)
f. use specific, expressive, and suitable language.

LIBRARY/MEDIA EDUCATION FRAMEWORK

CONTENT OUTCOMES AND STUDENT PERFORMANCE STANDARDS
Outcome Statement:

1. THE STUDENT LOCATES, SELECTS AND USES A VARIETY OF INFORMATION SOURCES.
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
b. use the library for information and enjoyment.
c. use reference materials, such as almanac, encyclopedia, dictionary, thesaurus and atlas.

By the end of grade 8
The student demonstrates the ability to:
b. use the information resources and personnel of the school, community and other libraries.
c. use reference materials such as indexes, periodicals, specialized subject encyclopedias/dictionaries.

5. THE STUDENT VALUES AND USES THE SKILLS AND ATTITUDES OF AN INDEPENDENT LIFELONG LEARNER.
Benchmarks/Performance Standards:

By the end of grade 8
The student demonstrates the ability to:
b. locate the correct source for specific information.
d. prepare reports from a variety of sources.
e. select appropriate sources to meet personal information needs.

CONTENT OUTCOMES AND STUDENT PERFORMANCE STANDARDS.
Outcome Statement:

1. THE STUDENT DEVELOPS PROBLEM-SOLVING ABILITIES FOR APPLICATION IN REAL LIFE SITUATIONS:
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
b. verify and interpret results.

By the end of grade 8
The student demonstrates the ability to:
b. verify and interpret results and apply solutions and strategies to new problem situations.

By the end of grade 12 or exit
The student demonstrates the ability to:
a. use, with increasing confidence, appropriate integrated mathematical problem-solving strategies and apply them to solve problems from within and outside mathematics.
c. determine, collect, organize and analyze the relevant data needed to solve real world problems.

2. THE STUDENT DEVELOPS AND PRACTICES EFFECTIVE COMMUNICATION USING MATHEMATICAL IDEAS AND RELATIONSHIPS.
Benchmarks/Performance Standards:

By the end of grade 8
The student demonstrates the ability to:
a. model situations using oral, written, graphical, algebraic, and multimedia techniques.
b. use appropriate communication skills to reach, interpret, questions, evaluate, and present mathematical ideas.

By the end of grade 12 or exit
The student demonstrates the ability to:
b. formulate and express, orally and in writing, mathematical definitions, generalizations and ideas.
c. use mathematical notation to facilitate the simplification of mathematical ideas and relationships.

3. THE STUDENT APPLIES REASONING SKILLS TO DEVELOP, ANALYZE AND DEFEND LOGICAL ARGUMENTS.
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
a. use models, known facts, properties and relationships.

By the end of grade 12 or at exit
The student demonstrates the ability to:
c. construct, test, and/or validate a logical argument using inductive or deductive reasoning.

4. THE STUDENT RECOGNIZES MATHEMATICS AS A CONNECTED BODY FOR KNOWLEDGE THAT IS AN INTEGRAL PART OF SOCIETY.
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
a. recognize and develop relationships among different topics in mathematics, other curricular areas and the physical world.

By the end of grade 8
The student demonstrates the ability to:
a. recognizes relationships within and among topics in mathematics and their applications in other disciplines.
b. use mathematics in describing the physical world.

By the end of grade 12 or at exit
The student demonstrates the ability to:
a. recognize equivalent representations of the same concept.
b. recognize and use the connections among and between mathematical topics.
c. recognize and use the connections between mathematics and other disciplines.

7. THE STUDENT DEMONSTRATES CONFIDENCE IN USING MATHEMATICS.
Benchmarks/Performance Standards:

By the end of grade 8
The student demonstrates the ability to:
a. solve problems, communicate ideas, and reason.
b. persevere in mathematical tasks.

By the end of grade 12 or at exit
The student demonstrates the ability to:
a. show evidence that mathematics is a common human activity.
b. persevere in mathematical tasks showing interest, curiosity, and inventiveness.

8. THE STUDENT UNDERSTANDS AND APPLIES NUMBER CONCEPTS TO CALCULATIONS AND ESTIMATIONS.
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
c. apply appropriate estimation strategies in working with quantities, measurement, computation and problem solving.

By the end of grade 8
The student demonstrates the ability to:
a. compute and estimate with whole numbers, fractions, decimals, integers, rational, and real numbers.
b. select and use appropriate methods for computation and estimation.

By the end of grade 12 or at exit
The student demonstrates the ability to:
a. analyze and explain procedures for computation as well as techniques for estimation.
b. apply appropriate computation and estimation skills to attain reasonable solutions.

10. THE STUDENT USES PATTERNS, RELATIONSHIPS, AND ALGEBRAIC CONCEPTS TO SOLVE PROBLEMS.
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
b. represent and describe mathematical relationships including the use of variables and open sentences to express relationships.

By the end of grade 8
The student demonstrates the ability to:
a. develop and use tables, graphs, and rules to identify properties and relationships.
b. investigate patterns in number sequences, make predictions, and formulate verbal rules to describe patterns.

By the end of grade 12 or exit
The student demonstrates the ability to:
a. explore, represent, and analyze functions and other situations that involve variable quantities in a variety of ways, including but not limited to expressions, equations, inequalities, tables, graphs and matrices.

11. THE STUDENT USES DATA ANALYSIS, PROBABILITY, AND STATISTICAL METHODS TO FORMULATE SOLUTIONS TO PROBLEMS
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
a. collect, organize and describe data.
b. formulate and solve problems that involve collecting and analyzing data.

By the end of grade 8
The student demonstrates the ability to:
a. systematically collect, organize, describe, and evaluate data.
c. make and compare predictions based on experimental or theoretical probability.

By the end of grade 12 or exit
The student demonstrates the ability to:
a. construct, draw inferences, and predict outcomes from data expressed in a variety of ways.
b. understand sampling and recognize its role in statistics.

SCIENCE FRAMEWORK
CONTENT OUTCOMES AND STUDENT PERFORMANCE STANDARDS
Outcome Statements:

1. THE STUDENT RECOGNIZES THE IMPORTANCE OF LIFELONG LEARNING IN SCIENCE AND TECHNOLOGY.
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
a. generate questions about the world based on observing.
d. recognize enjoyable aspects of science.
e. recognize a variety of tools and technology used in science.

By the end of grade 8
The student demonstrates the ability to:
a. apply scientific knowledge to real life situations.
b. understand and use science to make informed choices.
c. recognize career possibilities in science.
d. develop imaginative solutions to community needs.
e. recognize that science can provide enjoyment as a leisure activity.

By the end of grade 12 or exit
The student demonstrates the ability to:

a. apply and integrate scientific knowledge to real life situations.
b. explore career possibilities in science.
c. actively explore natural phenomena.

2. THE STUDENT USES SCIENCE AS A PROCESS TO CONDUCT INVESTIGATIONS, SUPPORT FINDINGS, AND COMMUNICATE RESULTS.
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:

a. create questions based on observations and suggest possible solutions.
b. use simple scientific tools in conducting investigations.
c. communicate in a variety of ways (oral, written, visual) using technology when appropriate.

By the end of grade 8
The student demonstrates the ability to:

a. identify problems, create questions based on observations, and suggest possible solutions.
b. recognize what constitutes data.
c. collect, record and organize data to form conclusions and generate new questions.
d. use interdisciplinary skills in science.
f. develop an opinion about science issues and discuss these issues with others.
g. communicate effectively in a variety of ways (oral, written, visual) using technology, when appropriate.

By the end of grade 12 or exit
The student demonstrates the ability to:

a. solve problems in various forms (e.g., mathematically, graphically, experimentally, etc.).
b. collect accurate and precise data, determine relationships among the data, and use the relationships to solve problems.
d. integrate interdisciplinary skills in science.
f. integrate communication skills in a variety of ways (oral, written, visual) using appropriate technology.
g. design and complete an experiment.
i. recognize the role of creativity in problem solving.

3. **THE STUDENT DEMONSTRATES KNOWLEDGE OF SCIENTIFIC CONCEPTS AND PRINCIPLES, AND RELATES THEM TO COMMON THEMES OF SCIENCE--THE NATURE OF SCIENCE, SYSTEMS, PATTERNS, ENERGY AND MATTER, CAUSE AND EFFECT, AND MODELS.**
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
a. identify the components of basic biological and physical systems.
b. identify change as a process in nature.
e. recognize cause and effect relationships in nature and society.

By the end of grade 8
The student demonstrates the ability to:
a. identify the components of biological and physical systems and communicate interactions.
b. identify the importance of change and constancy in nature.
c. predict the results of change.
e. recognize how matter changes phase.
f. describe cause and effect relationships in nature and society.

By the end of grade 12 or exit
The student demonstrates the ability to:
a. make predictions based on models, observations and experiments.
b. demonstrate appropriate units of measurement.
c. analyze biological, chemical and physical systems, identify their components and describe their interactions.
d. evaluate and predict change as a process in nature.
h. compare and contrast cause and effect relationships in physical, biological and chemical systems.

4. **THE STUDENT RECOGNIZES THE INTERRELATIONSHIPS AMONG SCIENCE, TECHNOLOGY, ENVIRONMENT AND SOCIETY.**
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
b. identify ways that people affect the environment.
c. recognize the individual as a part of these interrelationships.

By the end of grade 8
The student demonstrates the ability to:

a. describe the interrelationships among science, technology, environment, and society.
b. recognize the role of the individual and the community as a part of these interrelationships.
c. recognize the interdependence of the biological, physical and chemical aspects of science.

By the end of grade 12 or exit
The student demonstrates the ability to:

a. qualify and quantify the roles of the individual and community in these interrelationships.
b. qualify and quantify the global perspective of these interrelationships.
c. evaluate the complexity of these interrelationships.
d. make decisions which lead to responsible behaviors by individuals, communities and nations.
e. analyze the interdependence of the biological, physical and chemical aspects of science.

5. THE STUDENT APPLIES SCIENCE CONCEPTS AND COMPLEX THINKING SKILLS, AS APPROPRIATE, IN DECISION MAKING.
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:

a. apply basic science concepts from the biological and physical world to familiar situations.
b. act in an environmentally responsible manner
c. think in a scientific manner.

By the end of grade 8
The student demonstrates the ability to:

a. think in a scientific manner.
b. distinguish between scientific evidence and personal opinion.
c. use complex thinking processes to solve problems and make decisions.
d. recognize thinking processes to solve problems and make decisions.
e. act in an environmentally responsible manner.

By the end of grade 12 or exit
The student demonstrates the ability to:

b. evaluate scientific evidence and distinguish it from personal opinion.
c. synthesize information from a variety of sources; evaluate sources for validity, reliability and significance.
d. integrate the biological, physical and chemical aspects of science in decision making.
e. act in an environmentally responsible manner.

SOCIAL STUDIES FRAMEWORKS

CONTENT OUTCOMES AND STUDENT PERFORMANCE STANDARDS:
Outcomes Statements:

1. THE STUDENT ANALYZES MAJOR FORCES AFFECTING WORLD HISTORY, U.S. HISTORY, AND NORTH DAKOTA HISTORY FROM THE PREHISTORIC PERIOD TO THE PRESENT.
Benchmarks/Performance Standards:

By the end of grade 8
The student demonstrates the ability to:
d. analyze and apply how societies have been and are organized in the western and nonwestern world and how people have interacted throughout history.

By the end of grade 12 or at exit
The student demonstrates the ability to:
a. analyze and synthesize the major religious, political, cultural, economic and geographic forces affecting world and United States history from the prehistoric period to the present.

2. THE STUDENT COMPARES AND CONTRASTS HOW POLITICAL INSTITUTIONS AND SYSTEMS, PAST AND PRESENT, RESPOND TO INTERNAL AND EXTERNAL CONFLICT AND CHANGE.
Benchmarks/Performance Standards:

By the end of grade 8
The student demonstrates the ability to:
b. develop an understanding of democratic institutions and civic competency through knowledge of and active involvement in political, social or economic issues.

4. THE STUDENT FINDS, EXAMINES AND USES, IN A CRITICAL MANNER, SOCIAL STUDIES INFORMATION RESOURCES.
Benchmarks/Performance Standards:

By the end of grade 8
The student demonstrates the ability to:
b. critically analyze contemporary issues from multiple sources and perspectives.

By the end of grade 12 or at exit
The student demonstrates the ability to:
a. make decisions based on the analysis of social studies information resources.
b. critically analyze visual and printed sources.

7. **THE STUDENT ANALYZES LOCAL, NATIONAL AND WORLD ECONOMIC PROBLEMS FROM THE PERSPECTIVES OF PRODUCER, CONSUMER, WORLD CITIZEN AND DECISION MAKER.**
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
a. examine economic problems and the variety of resources available in North Dakota and their effect on community, nation and the world.

By end of grade 8
The student demonstrates the ability to:
a. describe the economic concepts of wants and needs, supply and demand, goods and services, scarcity, renewable and nonrenewable resources as they apply to national and world economic problems.

By end of grade 12 or exit
The student demonstrates the ability to:
a. compare and contrast the basic principles and systems of economics and the problems that are inherent to these systems.
b. analyze and investigate possible solutions to economic problems.
c. examine how global interdependence impacts many aspects of contemporary life.

11. **THE STUDENT APPLIES THE FIVE THEMES OF GEOGRAPHY TO SOCIAL STUDIES ISSUES.**
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
a. locate on a world map major land masses, bodies of water, the United States and its neighbors.
b. describe the movement of people, natural resources, products and ideas across the nation.
d. recognize the regions of the United States describing the geography, climate, resources, industries and occupations of each area.

By the end of grade 8
The student demonstrates the ability to:
a. identify and explain the importance of the five themes of geography: location, place, human-environmental interactions, movement and regions to social studies issues.

By the end of grade 12
The student demonstrates the ability to:
a. comprehend the relationships between geographic location and contemporary and historic events.
b. use the five themes of geography as a foundation for geographic analysis.

13. THE STUDENT IS WILLING TO USE SOCIAL STUDIES PERSPECTIVES IN LIFELONG LEARNING.
Benchmarks/Performance Standards:

By the end of grade 4
The student demonstrates the ability to:
a. use social studies information to make decisions and solve problems.

By the end of grade 8
The student demonstrates the ability to:
a. examine the interrelationships of history, geography, the social sciences and the humanities.
b. discuss the complexities inherent to an ever-changing world.

By the end of grade 12 or at exit
The student demonstrates the ability to:
a. compare and contrast issues and events of the past to understand the present and gain insights into the future.
b. develop educated opinions and express them in various forums.

14. THE STUDENT UNDERSTANDS THE IMPORTANCE OF ETHICS AND VALUES AND HOW THEY INFLUENCE THE BEHAVIOR OF INDIVIDUALS AND SOCIETY.
Benchmarks/Performance Standards

By the end of grade 8
The student demonstrates the ability to:
a. examine how society is governed by laws which influence personal behavior and which seek to provide for the common good.

By the end of grade 12 or at exit
The student demonstrates the ability to:
a. evaluate perceptions, stereotypes, and prejudices directed toward individuals, groups, cultures and nations.

ARTS EDUCATION FRAMEWORKS

CONTENT OUTCOMES AND STUDENT PERFORMANCE STANDARDS

Outcome Statements:

1. THE STUDENT GAINS AN UNDERSTANDING OF THE MULTICULTURAL, HISTORICAL, AND SOCIAL CONTEXT OF THE ARTS.
Benchmarks/Performance Standards:

By the end of grade 4 (visual art)
c. use community and cultural resources in the study of visual art.

By the end of grade 8 (visual art)
d. use community and cultural resources in the study of art.

By the end of grade 8 (dance)
The student demonstrates the ability to:
b. use community and cultural resources in the study of dance.

2. THE STUDENT LEARNS TO CREATE AND PERFORM IN THE ARTS.
Benchmarks/Performance Standards:

By the end of grade 4 (dance)
The student demonstrates the ability to:
a. respect and appreciate the human body as an instrument for expression and communication.
c. develop patterns and combination of movements into repeatable sequences.

By the end of grade 4 (music)
The student demonstrates the ability to:
a. sing songs accurately, independently, and in tune, reflecting an understanding of tonal and rhythmic concepts.
d. improvise short melodies and rhythms, using the elements of music (pitch, rhythm, harmony, tempo, dynamics, timbre form).

By the end of grade 4 (visual art)
The student demonstrates the ability to:
a. experience basic media and techniques in creating art.
c. experience enjoyment in creating art.
e. select art works for display from his/her collected work.

By the end of grade 8 (dance)
The student demonstrates the ability to:
a. perform a variety of dances (i.e., simple folk, country, line, creative).
c. collaborate with positive group interaction skills.

By the end of grade 8 (music)
The student demonstrates the ability to:

a. sing accurately, independently, and in tune, reflecting a broader understanding of tonal and rhythmic concepts. In addition, deal successfully with changing voice (male and female) and knowledge of the techniques that enable continued singing during this time of change.
b. sing songs demonstrative of the various musical style periods.

By the end of grade 8 (visual art)
The student demonstrates the ability to:

a. control basic media and technique in creating art.
c. effectively communicate ideas, attitudes, and feelings through visual art forms.
d. skillfully create and display one's own art.

By the end of grade 12 or at exit (music)
The student demonstrates the ability to:

a. perform with advanced skills, reflecting an understanding of historical style periods and a heightened awareness of musical elements, leading to advanced accompaniment and solo techniques.
b. exhibit skills in improvisation, expanding into contemporary style techniques, e.g., aleatoric, minimalist, etc.

3. THE STUDENT UNDERSTANDS THE NATURE AND VALUE OF THE ARTS AS AN INTEGRAL PART OF LIFE.
Benchmarks/Performance Standards:

By the end of grade 4 (dance)
The student demonstrates the ability to:

a. identify activities that contribute to personal feelings of joy.
b. demonstrate leadership and spontaneous thinking.
c. appreciate the art of dance and its relationship to self-esteem.
d. interact with positive social skills.

By the end of grade 4 (visual art)
The student demonstrates the ability to:

a. observe, synthesize, and verbalize one's art experiences.
b. recognize that humans learn through engagement in the visual process.

By the end of grade 8 (dance)
The student demonstrates the ability to:

a. value the freedom to make choices in artistic expression.
c. develop self-awareness and confidence.

By the end of grade 8 (visual art)
The student demonstrates the ability to:

a. observe, synthesize and describe art experiences and their importance.
b. develop an expanded level of visual awareness by applying the elements of art and principles of design.
c. understand and apply basic art techniques to facilitate problem solving in further life applications.

4. THE STUDENT LEARNS TO MAKE CRITICAL EVALUATIONS IN THE ARTS.
Benchmarks/Performance Standards:

By the end of grade 4 (dance)
The student demonstrates the ability to:

a. discuss ethical and unethical behavior during movement.
b. perceive and describe dance using appropriate oral vocabulary.
c. move safely without interfering with the personal space of others.

By the end of grade 4 (visual art)
The student demonstrates the ability to:

d. recognize originality in artistic expression.

By the end of grade 8 (dance)
The student demonstrates the ability to:

c. focus and concentrate in viewing dance.
d. perceive and describe dance using appropriate oral and written vocabulary.

By the end of grade 8 (visual arts)
The student demonstrates the ability to:

c. recognize and value originality in artistic expression.

APPENDIX B - LIST OF SKILLS

Analysis
Application
Classification
Communication
Comparing Similarities and Differences
Computation
Cooperative Learning
Critical Thinking
Data Collection
Debate
Description
Discussion
Drawing
Effective Social (Group) Participation
Estimating
Evaluation
Experimenting
Extrapolation
Generalization
Graphing
Hypothesis Formation and Testing
Identification
Inference
Interpretation
Interview
Invention
Kinesthetic Concept Development
Library Skills
Listening
Listing
Mapping
Matching
Measuring
Media Construction
Observation
Prediction
Problem Solving
Psychomotor Development
Public Speaking
Reading
Recognition
Reporting
Research
Resolving Problems
Singing
Small Group Work
Spelling
Synthesis
Theory Formation and Testing
Using Time and Space
Visualization
Writing

APPENDIX C - NORTH DAKOTA AGENCIES AND ORGANIZATIONS ASSOCIATED WITH WETLANDS CONSERVATION

PUBLIC AGENCIES - STATE OF NORTH DAKOTA

NDSU Extension Service

Provides technical assistance and educational materials for wetlands management and agricultural conservation practices that can benefit both landowners and wildlife. Serves as a clearinghouse for matching landowners with programs that can compensate or provide incentives to landowners to manage wetlands and other lands to benefit wildlife. Contact the Wildlife Specialist at NDSU or your local NDSU Extension Service County Agent.

NDSU Extension Wildlife Service
Room 181, Hultz Hall
NDSU
Fargo, ND 58105
(701) 237-7950

North Dakota State Department of Health and Consolidated Laboratories

Administrates water quality programs and develops and enforces water quality standards for the state of North Dakota. Also administers lake restoration projects.

North Dakota Department of Health and Consolidated Laboratories
Environmental Health Section
P.O. Box 5520
Bismarck, ND 58502-5520
(701) 328-5210

North Dakota Geological Survey

North Dakota Geological Survey
1022 East Divide Ave.
Bismarck, ND 58501
(701) 328-4109

North Dakota Game and Fish Department

Involved in several wetland programs and provides funding for wetland and other wildlife habitat improvements. Areas of involvement include: habitat improvement, harvesting regulations and enforcement, land acquisitions, food plot development, wetland restorations, education materials, and serves on many boards and committees affecting wetland policy. Contact your local game warden or the main office in Bismarck.

Wildlife Division
N.D. Game and Fish Department
100 N. Bismarck Expressway
Bismarck, ND 58501
(701) 328-6300

Bismarck Office
812 Airport Road
Bismarck, ND 58501
(701) 328-2199

Spiritwood Lake Field Office Stn.
RR 1, Box 224
Jamestown, ND 58401
(701) 252-4681

Oakes Office
P.O. Box 7
Oakes, ND 58474
(701) 742-2271

Riverdale Office
P.O. Box 506
Riverdale, ND 58565
(701) 654-7475

Rugby Office
Lunde Building
Rugby, ND 58368
(701) 776-5185

Devils Lake Office
P.O. Box 889
Devils Lake, ND 58302
(701) 662-3617

Dickinson Office
RR 1, Box 56
Dickinson, ND 58601
(701) 227-2343

Mott Office
409 Brown Ave.
Mott, ND 58646
(701) 824-2337

Williston Office
P.O. Box 2476
Williston, ND 58802
(701) 774-4320

Lisbon Office
RR 2, Box 295, Hwy 32S
Lisbon, ND 58045
(701) 683-4900

North Dakota State Water Commission and State Engineer

The State Engineer oversees regulatory programs affecting water management in the state, which includes drainage laws and sovereign lands (lake and stream beds of navigable waterways in the state). The Water Commission oversees water development and promotion, including Project WET, a program to provide teachers materials about water management. The State Engineer also acts as secretary to the Water Commission.

North Dakota State Water Commission and State Engineer
900 E. Boulevard
Bismarck, ND 58505
(701) 328-2750

PUBLIC AGENCIES - FEDERAL

Natural Resources Conservation Service

Provides technical assistance for conservation provisions of the Food Security Act. Assists landowners with conservation compliance plans and makes wetland and minimal effects determinations for swampbuster. Assists Agriculture Stabilization and Conservation Service with administration of the federal waterbank program. Each county has a local office.

State Office
Natural Resources Conservation Service
220 Rosser Ave.
Bismarck, ND 58501
(701) 250-4421

Wetland Management Districts (WMD) and National Wildlife Refuges (NWR)

Arrowwood NWR
RR 1
Pingree, ND 58476
(701) 285-3341

Audubon NWR
RR 1, Box 16
Coleharbor, ND 58531
(701) 442-5474

Long Lake NWR
RR 1, Box 23
Moffit, ND 58560
(701) 387-4397

Lake Ilo NWR
Box 127
Dunn Center, ND 58626
(701) 548-8110

Crosby Wetland Management District
P.O. Box 148
Crosby, ND 58730
(701) 965-6488

Long Lake NWR
RR 1, Box 23
Moffit, ND 58560
(701) 387-4397

PUBLIC AGENCIES - FEDERAL (Continued)

Wetland Management Districts and National Wildlife Refuges - (Continued)

Devils Lake Wetlands Management District
P.O. Box 908
Devils Lake, ND 58301
(701) 662-8611

Kulm Wetland Management District
Box E
Kulm, ND 58456
(701) 647-2866

Upper Souris NWR
RR 1, Box 163
Foxholm, ND 58738
(701) 468-5467

Valley City Wetland Management District
11515 River Road
Valley City, ND 58072
(701) 845-3466

Chase Lake Prairie Project
RR 1, Box 144
Woodworth, ND 58496
(701) 752-4218

Des Lacs NWR
Box 578
Kenmare, ND 58746
(701) 385-4046

Lostwood Wetlands Mgnt. District
RR 2, Box 98
Kenmare, ND 58746
(701) 848-2466

J. Clark Salyer NWR
P.O. Box 66
Upham, ND 58789
(701) 768-2548

Tewaukon NWR
RR 1, Box 75
Cayuga, ND 58013
(701) 724-3598

PRIVATE CONSERVATION ORGANIZATIONS (NONGOVERNMENTAL)

National Audubon Society

A national nonprofit conservation organization that directly affects wetland policy in North Dakota through lobbying effects in the U.S. Congress. Has acquired land for wildlife sanctuaries. Serves on several wetland boards in North Dakota and participates in public debate for wetland issues in the state.

Contact for Agriculture and Water Resources Policy:
National Audubon Society
801 Pennsylvania Ave. SE
Washington, DC 20003
(202) 547-9009

North Dakota Contact: Alkali Lake Sanctuary
Rt. 1, Box 79A
Spiritwood, ND 58481
(701) 252-3822

Dakota Wildlife Trust

A statewide nonprofit organization established to improve wildlife habitat on private lands. Operates the Youth for Wildlife food and habitat plot contest and the Hides for Habitat program.

Dakota Wildlife Trust
Box 572
Valley City, ND 58072
(701) 237-7950

Ducks Unlimited, Inc.

A nonprofit corporation that enhances wetlands and waterfowl habitat on public lands and private lands in North America. The majority of DU's private lands work in North Dakota is done in cooperation with federal and state agencies.

Ducks Unlimited, Inc.
U.S. Habitat Office
3502 Franklin Ave.
Bismarck, ND 58501
(701) 258-5599

North Dakota Wetlands Trust

A nonprofit corporation, established as part of the Garrison Diversion Reformulation Act, to protect, restore and enhance wetlands and associated wildlife habitat in North Dakota. Projects include acquisition of wetlands and the Create-a-Wetland Program.

North Dakota Wetlands Trust
P.O. Box 3175
Bismarck, ND 58502
(701) 223-8501

North Dakota Chapter of The Wildlife Society

North Dakota Chapter of The Wildlife Society
P.O. Box 1442
Bismarck, ND 58502

The Nature Conservancy

An international nonprofit organization which protects unique areas and rare species by conserving the land and water they need to survive, through land acquisitions and cooperative ventures with other entities. Also jointly operates the N.D. Natural Areas Registry with the N.D. Parks and Recreation Department, which recognizes landowners who voluntarily protect unique natural areas.

Dakotas Field Office
The Nature Conservancy
1014 E. Central Ave.
Bismarck, ND 58501
(701) 222-8464

National and North Dakota Wildlife Federation

The National Wildlife Federation affects wetland programs in North Dakota through lobbying effects in Congress and litigation of illegal wetland activities in the state. The North Dakota Wildlife Federation works with local wildlife clubs to improve wildlife habitat and promote wildlife conservation.

N.D. Wildlife Federation
1605 E. Capitol Ave.
Bismarck, ND 58501
(701) 222-2557

National Wildlife Federation
1605 E. Capitol Ave.
Bismarck, ND 58501
(701) 222-2442

WATER ORGANIZATIONS

Garrison Diversion Conservancy District

Garrison Diversion Conservancy District
P.O. Box 140
Carrington, ND 58421
(701) 652-3194

North Dakota Water Resource Districts Association

North Dakota Water Resource Districts Association
1501 N. 12th Street
Bismarck, ND 58501
(701) 223-4615

North Dakota Water Users Association

A nonprofit organization dedicated to the protection, development, and management of North Dakota's water resources. It is also directly involved in establishing wetland policy in North Dakota.

North Dakota Water Users Association
1501 N. 12th Street
Bismarck, ND 58501
(701) 223-4615

GENERAL INFORMATION

Major Federal Authorities and other Efforts for Wetlands Protection

The primary federal authorities which have provision for protection of wetland resources, include the following:

1. Fish and Wildlife Act of 1956
2. Fish and Wildlife Coordination Act
3. Migratory Bird Treaty Act
4. Endangered Species Act
5. National Environmental Policy Act
6. Section 404 of the Clean Water Act of 1977
7. Section 10 of the Rivers and Harbors Act
8. Coastal Zone Management Act
9. Coastal Barrier Resources Act of 1982
10. Watershed Protection and Flood Prevention Act
11. Federal Power Act
12. Food Security Act of 1985
13. Emergency Wetlands Resources Act of 1986
14. Executive Order 11990
15. Water Bank Act of 1970
16. Section 402 of the Clean Waters Act
17. 1986 Tax Reform Act
18. National Flood Insurance Program (of the Flood Disaster Protection Act of 1968 and 1977)
19. 1986 Water Resources Development Act
20. North American Waterfowl Management Plan
21. North American Wetlands Conservation Act of 1989
22. FmHA Conservation Easements on Foreclosed Lands
23. President Bill Clinton establishes a no net loss of wetlands policy.

The acquisition of lands (either through purchase or donation), especially wetlands, for inclusion in the National Wildlife Refuge System is authorized by the Migratory Bird Conservation Act and funding for acquisition of refuge lands (including waterfowl production areas) is authorized by:

25. The Migratory Bird Hunting and Conservation Stamp Act
26. Wetlands Loan Act
27. Land and Water Conservation Fund Act of 1965

The Federal Government also provides technical assistance and grants in aid to states for fisheries and wildlife conservation purposes. Monies from these grants are sometimes used for wetland conservation. These grants are provided through two programs:

28. The Federal Aid to Wildlife Restoration Act of 1937 (Pittman-Robertson Act)
29. The Federal Aid in Fish Restoration Act of 1950 (Dingell-Johnson Act)

These authorities (1.-29.) listed above are described in the following paragraphs. Most of the information has been extracted from "The Impact of Federal Programs on Wetlands, Volume I: The Lower Mississippi Alluvial Plain and the Prairie Pothole Region," a report to Congress by the Secretary of the Interior, October 1988.

LEGISLATIVE AND ADMINISTRATIVE AUTHORITIES

1. The **Fish and Wildlife Act** of 1956 authorizes the development and distribution of fish and wildlife information to the public, Congress and the President, and the development of policies and procedures that are necessary and desirable to carry out the laws relating to fish and wildlife. This act gives broad authority to the Secretary of the Interior (Secretary) to take such steps as "may be required for the development, advancement, management, conservation and protection" of fish and wildlife resources. The Secretary, in a required annual report to Congress, may make recommendations for additional legislation. The authority provides the U.S. Fish and Wildlife Service (Service), through the Department of Interior (Department), with an avenue for developing new policy and making recommendations for new legislation that could be used to improve Federal wetland protection alternatives.

2. The **Fish and Wildlife Coordination Act** (Coordination Act) authorizes the U.S. Fish and Wildlife Service to investigate ad report on Federal water resource development projects and non-Federal actions requiring a Federal permit or license. This Act specifies that fish and wildlife conservation shall receive equal consideration with other project purposes. This authority requires that a Federal agency consult with the Service and State fish and wildlife agency concerning the effects on fish and wildlife resources of a Federal water resource development project or non-Federal water development project requiring a permit or license. Federal agencies authorized to construct or operate water resource projects (primarily the Corps of Engineers and the Bureau of Reclamation) or approve permits and licenses for non-federal projects (primarily the Corps and the Federal Energy Regulatory Commission) are required to give full consideration to the Coordination Act report and recommendations of the Secretary. However, agencies may make determinations that do not result in adoption of the Service's recommendations.

3. The **Migratory Bird Treaty Act** (Treaty Act) authorizes the preservation and restoration of migratory and game bird populations. This authority provides broad Federal responsibility including regulatory authority to protect migratory birds. The U.S. has negotiated migratory bird treaties with Japan and the Union of Soviet Socialist Republics that contain provisions committing the parties to protect migratory bird habitats. However, these treaties by themselves do not provide the legal authority to implement these agreements, because they

are not self-executing. The Treaty Act focuses primarily on preventing the unlawful taking, killing or possession of migratory birds, and does not contain habitat provisions that provide the Department with explicit authority to protect wetland habitats crucial to migratory birds.

4. The principal purpose of the **Endangered Species Act** is the conservation of threatened and endangered species and the ecosystems on which they depend. This is one of the stronger authorities to protect fish and wildlife resources, including wetland habitats for species listed as threatened or endangered. The Act provides regulatory authority to prohibit unauthorized taking and possession of endangered species. Section 7 of the Act requires Federal agencies to utilize their authorities to carry out programs for the conservation of endangered and threatened species. Section 7 also requires Federal agencies to ensure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of its designated critical habitat, and to consult with the Service in carrying out this responsibility.

5. The **National Environmental Policy Act** (NEPA) requires that the Federal official responsible for a major Federal action shall consult with and obtain the comments of any Federal agency which has jurisdiction by law or expertise with respect to any environmental impact. NEPA requires that Federal agencies provide detailed environmental statements on the environment of, the expected environmental impacts of, and the alternatives to a proposed action. NEPA documents make the positive and negative aspects of a proposed action available for public and agency scrutiny and comment. However, agencies having authority to implement or approve projects need not adopt recommendations to protect wetland resources or mitigate adverse impacts stemming from a proposed project.

6. **Section 404 of the Clean Water Act** of 1977 authorizes the Corps to issue permits for the discharge of dredged or fill material into waters of the United States. The purpose of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the nation's waters.

7. **Section 10 of the Rivers and Harbors Act** prohibits the unauthorized obstruction or the alternation of navigable waters by fills or construction of outfalls, piers, levees, etc. or work such as dredging without a permit from the Corps. The Section 10 authority is generally limited to coastal navigable waters and inland waterways, i.e., waters in which the transport of commerce occurs or occurred historically.

8. **The Coastal Zone Management Act** declares a national interest in the effective management, beneficial use, protection and development of the coastal zone. This act makes Federal funds available to encourage States to develop comprehensive management programs, in cooperation with Federal and local governments.

9. The **Coastal Barrier Resources Act** established a network of 186 units within 15 states along the Atlantic and Gulf coasts, within which most Federal expenditures are no longer available. There are certain exceptions to the general prohibition.

10. The **Watershed Protection and Flood Prevention Act** authorizes the U.S. Fish and Wildlife Service to make surveys and investigations and prepare a report for the conservation of

wildlife resources on Natural Resources Conservation Service (formerly Soil Conservation Service) small watershed projects. The Secretary of Agriculture is required to obtain the views and recommendations of the Department/Service prior to authorizing a project.

11. The **Federal Power Act,** as amended, provides for cooperation between the Federal Energy Regulatory Commission and other Federal agencies in the investigation of proposed power projects, and for other agencies to provide information to the Commission upon request. Section 4(e) of the Act requires acceptance of the Secretary of the Interior's mandatory terms and conditions to protect any Federal reservation occupied by a project and Section 30(c) requires acceptance of the Service's terms and conditions for exemptions from licensing.

    In 1986 the Federal Power Act was amended by the **Electric Consumers Protection Act** (ECPA). The ECPA provides that the Federal Energy Regulatory Commission (Commission) give equal consideration to the damage to and the protection, mitigation and enhancement of fish and wildlife. It further requires that each license issued by the Commission include conditions for the protection, mitigation, and enhancement of fish and wildlife resources based on recommendations provided by the Fish and Wildlife Service pursuant to the Fish and Wildlife Coordination Act.

12. The **Food Security Act** of 1985 (Farm Bill) eliminates most agricultural benefits to persons who produce commodities on wetlands converted after enactment. Under the Farm Debt Restructure provision, wetlands on private lands may be set aside and managed for fish and wildlife resources for at least 50 years, in exchange for debt relief to the landowner. Wetlands interspersed with highly erodible lands may be set aside for a period of 10 years under the Conservation Reserve Program. States and conservation organizations may obtain easements on wetlands and other habitats on Farmers Home Administration (FmHA) inventory lands (foreclosed lands) prior to resale, under Section 1314 of the Farm Bill.

13. The **Emergency Wetlands Resources Act** (Wetlands Act) was enacted in 1986 to promote the Conservation of our nation's wetlands in order to maintain the public benefits they provide. The intent was to intensify cooperative and acquisition efforts among private interests and local, State and Federal governments for the protection, management and conservation of wetlands. The Wetlands Act contains a broad variety of measures available to the Department to promote wetland conservation and to offset or prevent wetland losses. These include new options for generating revenues for acquisition and protection of wetlands, establishing a National Wetlands Priority Conservation Plan for wetland acquisition, requiring that Statewide Comprehensive Outdoor Recreation Plans specifically address wetlands, completing the mapping of the nation's wetlands, and studying the effects of Federal programs on wetlands.

14. **Executive Order 11990 - Protection of Wetlands,** was signed by President Carter in 1977. It directs each Federal agency to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values in carrying out agency responsibilities.

15. The Agriculture Stabilization and Conservation Service of the U.S. Department of Agriculture (USDA) administers the Water Bank Program, authorized by the **Water Bank**

Act of 1970. With technical assistance from USDA's Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service), landowners and operators enter into 10 year agreements with the Secretary of Agriculture to protect the wetland in exchange for annual payments. The surrounding upland must have sufficient cover to provide essential habitat for the nesting, breeding, or feeding of migratory waterfowl.

16. **Section 402 of the Clean Water Act of 1977** created the National Pollutant Discharge Elimination System (NPDES) which requires permits for discharge of wastes into waters of the United States from industrial and sewage treatment facilities and similar facilities. This permit program is generally administered by states with oversight by the Environmental Protection Agency.

17. The **1986 Tax Reform Act** eliminated or reduced prior tax provisions that created an incentive for converting wetlands for agricultural or industrial purposes.

18. The Flood Disaster Protection Act of 1968 and 1977 included the **National Flood Insurance Program** (NFIP). NFIP allows property owners to purchase insurance against losses from flooding, if local governments establish and enforce measures to reduce future flood risks to new construction in flood hazard areas. Thus, construction activities in flood hazard areas (floodplains) must meet certain requirements under this program, reducing the risk to loss from floods. In North Dakota, the State Water Commission assists local governments in establishing sound floodplain management.

19. The **1986 Water Resources Development Act** (WRDA) requires a local cash contribution for Army Corps of Engineers water projects. Previous to this law, local governments could provide an in-kind contribution of land, easements and right-of-ways. Although some in-kind contributions can still be credited to water control projects, the minimum local cash contribution must be equal to five percent of the construction cost. The act also requires 50-50 sharing of costs for studies conducted by the Corps which lead to the development of water projects, and makes the non-Federal sponsors responsible for all operation and maintenance costs. The WRDA applies not just to new projects, but to previously authorized projects which were not under construction when the law was passed.

20. The **North American Waterfowl Management Plan**, signed by Canada and the United States in 1986, set forth a course of action for both countries to take through the year 2000 to assure the continued survival of abundant waterfowl populations. The plan sets goals for duck, goose, and swan populations; identifies habitat conservation needs in specific regions of the continent; and recommends measures for resolving problems of international concern. The plan also requires each country, state, province, territory and waterfowl flyway to establish their own specific plans for habitat preservation and management in their respective jurisdictions. Population goals set for waterfowl are based on the average continental populations from 1970-79.

21. The **North American Wetlands Conservation Act of 1989** was passed to help fund the North American Waterfowl Management Plan. Also known as the Mitchell bill, it established a North American Wetlands Conservation Council, who recommends wetland conservation projects to the Migratory Bird Conservation Commission. The Council includes

the U.S. Fish and Wildlife Service Director, the Secretary of the Fish and Wildlife Foundation, four state wildlife agency directors, and three representatives of conservation organizations. Funding for the bill is from three sources: the Aid in Wildlife Restoration Act (Pittman-Robertson); proceeds from migratory bird fines, penalties and forfeitures under the Migratory Bird Treaty Act; and authorized appropriations. At least 50 percent, but not more than 70 percent will be used for work in Canada and Mexico.

22. The Farmers Home Administration can place **Conservation Easements on Foreclosed Lands** under the 1985 Food Security Act. Cooperating agencies provide recommendations for placing easements or deed restrictions on FmHA inventory lands (foreclosures). FmHA may grant or sell easement or restrictions to a unit of state or local government or private nonprofit organization. These conservation easements can protect: fish and wildlife habitats, floodplain and wetland areas, highly erodible land, important farmlands, aquifer recharge areas, areas of high water quality or scenic value, and historic or cultural properties.

23. The **Clinton Administration** proposed a comprehensive package of improvements to Federal wetlands programs that reflect consensus among Federal agencies. The package includes a goal of **no overall net loss of the Nation's remaining wetlands** and the long-term goal of increasing the quality and quantity of the Nation's wetland resources base. The package includes better cooperation among Federal agencies to eliminate confusion and duplication.

ACQUISITION PROGRAMS

Aside from some special appropriations, primary funding for the nation's acquisition programs to protect wetlands comes from three sources:

24. Migratory Bird Hunting and Conservation Stamps

Since 1934, the U.S. Fish and Wildlife Service has sold Migratory Bird Hunting and Conservation Stamps, commonly known as "duck stamps," which must be purchased by waterfowl hunters ages 16 and older. Nonhunters may also purchase stamps.

25. Wetlands Loan Act

A related source of funding is the Wetlands Loan Act of 1961, which provides for interest-free loan advances toward wetland acquisition and easements. A total of $200 million has been authorized by this program, out of which approximately $147 million had been appropriated through fiscal year 1983.

26. The Land and Water Conservation Fund Act

The Land and Water Conservation Fund Act (LWCF) of 1965 funds the purchase of outdoor recreation lands and natural area, including wetlands. The U.S. Fish and Wildlife Service has used this source of funding to protect endangered species and important natural resource areas and to extend the National Wildlife Refuge System. From fiscal years 1967 through 1982, the Service used approximately $182 million of LWCF money to acquire some 221,000 acres of

land, an unknown portion of which are wetlands. The National Park Service also has used this source of funding for land purchases: from fiscal years 1965 through 1982, a total of $1.7 billion in outlays for 1.4 million acres were made. States also receive LWCF to protect important outdoor recreation resources, which may include wetlands.

TECHNICAL ASSISTANCE AND GRANTS IN AID

27. The **Federal Aid to Wildlife Restoration Act** of 1937 (Pittman-Robertson Act) provides grants to States for up to 75 percent of the cost of projects for the acquisition, restoration, and maintenance of wildlife areas, including wetlands. Grants are drawn from an 11 percent Federal excise tax on the sale of firearms and ammunition. Close to $1 billion has been given to state wildlife management agencies, which have acquired over 3.5 million acres, over 1.5 million of which are waterfowl areas.

28. The **Federal Aid in Fish Restoration Act** (1950) commonly known as the Dingell-Johnson Act, provides Federal assistance to States for projects pertaining to fisheries conservation and management. The provisions of the Dingell-Johnson Act are parallel to those of the Pittman-Robertson Act. Funds derived from the Federal excise tax on fishing equipment and bait are apportioned annually among the States - 40 percent on the basis of geographical area and 60 percent on the basis of the number of persons holding paid licenses to fish for sport or recreation. Funds so apportioned to the States are available for use by them for "fish restoration and management projects" or, since 1970, "comprehensive fish and wildlife resource management plans." The Federal share is not to exceed 75 percent of project costs and is allocated to the state wildlife agency.

Protection of Wetlands: Executive Order 11990

42 Fed. Reg. 26961 (1977)

By virtue of the authority vested in me by the Constitution and statutes of the United States of America, and as President of the United States of America, in furtherance of the Nation Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 *et seq.*), in order to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative, it is hereby ordered as follows:

SECTION 1. (a) Each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for (1) acquiring, managing, and disposing of Federal lands and facilities; and (2) providing Federally undertaken, financed, or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

(b) This Order does not apply to the issuance by Federal agencies of permits, licenses, or allocations to private parties for activities involving wetlands on non-Federal property.

SEC. 2. (a) In furtherance of Section 101 (b)(3) of the National Environmental Policy Act of 1969 (42 U.S.C. 4331 (b)(3)) to improve and coordinate Federal plans, functions, programs and resources to the end that the Nation may attain the widest range of beneficial uses of the environment without degradation and risk to health or safety, each agency, to the extent permitted by law, shall avoid undertaking or providing assistance for new construction located in wetlands unless the head of the agency finds (1) that there is no practicable alternative to such construction, and (2) that the proposed action includes all practicable measures to minimize harm to wetlands which may result from such use. In making this finding the head of the agency may take into account economic, environmental and other pertinent factors.

(b) Each agency shall also provide opportunity for early public review of any plans or proposals for new construction in wetlands in accordance with Section 2(b) of Executive Order No. 11514, as amended, including the development of procedures to accomplish this objective for Federal actions whose impact is not significant enough to require the preparation of an environmental impact statement under Section 102(2)(C) of the National Environmental Policy Act of 1969, as amended.

SEC. 3. Any requests for new authorizations or appropriations transmitted to the Office of Management and Budget shall indicate, if an action to be proposed will be located in wetlands, whether the proposed action is in accord with this Order.

SEC. 4. When Federally-owned wetlands or portions of wetlands are proposed for lease, easement, right-of-way or disposal to non-Federal public or private parties, the Federal agency shall (a) reference in the conveyance those uses that are restricted under identified Federal, State or local wetlands regulations; and (b) attach other appropriate restrictions to the uses of properties by the grantee or purchaser and any successor, except where prohibited by law; or (c) withhold such properties from disposal.

SEC. 5. In carrying out the activities described in Section 1 of this Order, each agency shall consider factors relevant to a proposal's effect on the survival and quality of the wetlands. Among these factors are:

(a) public health, safety, and welfare, including water supply, quality, recharge and discharge; pollution; flood and storm hazards; and sediment and erosion;

(b) maintenance of natural systems, including conservation and long term productivity of existing flora and fauna, species and habitat diversity and stability, hydrologic utility, fish, wildlife, timber, and food and fiber resources; and

(c) other uses of wetlands in the public interest, including recreational, scientific, and cultural uses.

SEC. 6. As allowed by law, agencies shall issue or amend their existing procedures in order to comply with this Order. To the extent possible, existing processes, such as those of the Council on Environmental Quality and the Water Resources Council, shall be utilized to fulfill the requirements of this Order.

SEC. 7. As used in this Order:

(a) The term "agency" shall have the same meaning as the term "Executive agency" in Section 105 of Title 5 of the United States Code and shall include the military departments; the directives contained in this Order, however, are meant to apply only to those agencies which perform the activities described in Section 1 which are located in or affecting wetlands.

(b) The term "new construction" shall include draining, dredging, channelizing, filling, diking, impounding, and related activities and any structures or facilities begun or authorized after the effective date of this Order.

(c) The term "wetlands" means those areas that are inundated by surface or ground water with a frequency sufficient to support and under normal circumstances does or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflows, mud flats, and natural ponds.

SEC. 8. This Order does not apply to projects presently under construction, or to projects for which all of the funds have been appropriated through Fiscal Year 1977, or to projects and programs for which a draft or final environmental impact statement will be filed prior to October 1, 1997. The provisions of Section 2 of this order shall be implemented by each agency not later than October 1, 1997.

SEC. 9. Nothing in this Order shall apply to assistance provided for emergency work, essential to save lives and protect property and public health and safety, performed pursuant to Section 305 and 306 of the Disaster Relief Act of 1974 (88 Stat. 148, 42 U.S.C. 5145 and 5146).

SEC. 10. To the extent the provisions of Sections 2 and 5 of this Order are applicable to projects covered by Section 104(h) of the Housing and Community Development Act of 1974, as amended (88 Stat. 640, 42 U.S.C. 5304(h)), the responsibilities under those provisions may be assumed by the appropriate applicant, if the applicant has also assumed, with respect to such projects, all of the responsibilities for environmental review, decision-making, and action pursuant to the National Environmental Policy Act of 1969, as amended.

JIMMY CARTER

The White House
May 24, 1977.

STATEMENT BY THE PRESIDENT ACCOMPANYING EXECUTIVE ORDER 11990

The Nation's coastal and inland wetlands are vital natural resources of critical importance to the people of this country. Wetlands are areas of great natural productivity, hydrological utility, and environmental diversity, providing natural flood control, improved water quality, recharge of aquifers, flow stabilization of streams and rivers, and habitat for fish and wildlife resources. Wetlands contribute to the production of agricultural products and timber, and provide recreational, scientific, and aesthetic resources of national interest.

The unwise use and development of wetlands will destroy may of their special qualities and important natural functions. Recent estimates indicate that the United States has already lost over 40 percent of our 120 million acres of wetlands inventoried in the 1950's. This piecemeal alteration and destruction of wetlands had an adverse cumulative impact on our natural resources and on the quality of human life.

The problem of loss of wetlands arises mainly from unwise land use practices. The Federal Government can be responsible for or can influence these practices in the construction of projects, in the management of its own properties, and in the provisions of financial or technical assistance.

In order to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative, I have issued an Executive order on the protection of wetlands.

ARTICLES OF INTEREST

Devils Lake Lemna ... naturally.
by Hope Aadland
North Dakota Water, January 1994.
Published by the North Dakota Water Education Foundation.
(Reprinted with permission of ©North Dakota Water Education Foundation)

A Sweet Deal.
by Kathleen Rude
Ducks Unlimited
May/June Vol. 55, No. 3.
(Reprinted with permission from ©Ducks Unlimited, Incorporated)

Devils Lake Lemna . . .

(Reprinted with permission of the North Dakota Water Education Foundation)

naturally

Story and photos by Hope Aadland

It seems nature can't keep up with pollution these days. But that's not true in Devils Lake. A small aquatic plant is providing a natural solution for the city's longtime wastewater treatment problems.

Most cities traditionally have problems finding and maintaining environmentally healthy, cost-effective sewage projects. But with the huge closed basin of nearby Devils Lake, the city of the same name had found itself in a unique situation in trying to find an effective wastewater treatment solution.

SEARCHING FOR A SYSTEM

Between 1954 and 1972, Devils Lake had only one to three lagoon cells for wastewater treatment. The city had secondary treatment, and sewage went straight to the lake. But even three lagoon cells weren't adequate. When the area received a lot of rain, sewage just bypassed the system because it was not designed to handle the increased flow.

In the late 1970s, a sewer separation project was completed to avoid the bypassing. But there were still problems. The algal blooms in the lagoon went directly to Creel Bay, a popular residential and recreational area on Devils Lake.

"The public didn't like seeing green water coming into the bay," said Glenn Olson, director of public works in Devils Lake.

It was then time to look at other options. The city considered everything from Sheyenne River discharge to mechanical and chemical treatment. Then the State Health Department provided some information on the Lemna System.

"The system was to be designed for no net negative impact on Creel Bay," Olson said.

PROJECT UNDERWAY

Soon after, the Lemna Corporation of St. Paul, Minn., came up with a pilot project for Devils Lake. They tested it for a year and it worked, so the

company designed a full-scale wastewater treatment system. In 1990, the Lemna Corporation began to help manage the Devils Lake system for two summers.

Cost also drew the city to using a Lemna system. At $4.5 million ($2 million for Lemna and $2.5 million for lagoon upgrades), it was half as much as the next preferred option. But there was still some resistance.

"It took a lot of town meetings. There was skepticism to start with because it is a fairly low-tech system," Olson said. "People like the black box approach — sewage in, water out. It's better when it has a lot of flashing lights and buttons."

But, he said, the public favored a system that would not pollute any more and alleviate high future costs. The Lemna System cost only $150,000 a year to run. And two-thirds of the construction costs were funded as an innovative project by the Environmental Protection Agency. Thus, the Lemna System won out over the others.

The Devils Lake Lemna System

NEAR-PERFECT SYSTEM

The Lemna System is unique because it is a natural and environmentally sound waste water treatment system. It merges the cleansing properties of duckweed with engineering to produce a highly efficient system, one Lemna Corporation brochure says.

The main benefit is its reduced operational costs and using the sun for the system's energy requirements, rather than buying electricity. Lemna Systems also neutralize sewage odors, and reduce sludge and the need for costly sludge management programs. Also, mosquitoes can't grow in a Lemna System because there is no surface water.

Desiree Heil, a regional sales manager for the Lemna Corporation, said there are 30 to 40 completed Lemna projects all over the world, including Italy, Belgium, Mexico, Poland. Most, however, are in the United States. The Devils Lake Lemna System is the largest in the world in terms of number of people served.

The Devils Lake System needed size because of North Dakota's cold climate, Heil said. Large spreads of plants need to capture the little sunlight North Dakota summers offer. The plant is from the family Lemnaceae, better known as duckweed or water lentil, and is the workhorse of the system. Throughout the world, there are more than 40 species of duckweed that can be used in Lemna systems. These floating aquatic plants, no bigger than the head of a thumbtack, have thrived on the earth for millions of years on pollutants found in calm waters.

PROBLEMS

The system may be virtually flawless, but a unique situation came up in Devils Lake that Olson says he can laugh about now.

"When the Lemna System was being built, we hauled in the duckweed from the James River, it sat in a truck overnight [at the

▼ **Lemnaceae, commonly known as duckweed, naturally cleans the wastewater in the Lemna System.**

System site]. A few weeks later we saw some really nice minnows," he said. "But we found out they were carp and had come up as eggs in the duckweed."

Olson said there turned out to be millions of carp, and they had to spend $13,000 to eliminate them. Although the carp weren't dangerous to the System, they could have gotten into the Lake and upset its ecological balance.

The Lemna harvester is one of the few pieces of equipment necessary to run the Lemna System.

DEVILS LAKE'S SYSTEM

The Devils Lake Lemna System, just west of town, includes three stabilization lagoons connected together over a 240-acre area. The floating duckweed is held in place by a large system of plastic grids set up like an ice cube tray.

For the duckweed to be effective in water treatment, Heil said it must stay spread out over the water, and not become bunched up in one area by the wind. When more duckweed grows than is needed, Olson and local Lemna maintenance personnel skim the surface with the pontoon-like harvester machine and collect the duckweed. The harvested duckweed is ground for use in silage or given to local farmers as fertilizer for fields.

The Devils Lake Lemna System serves a summertime population of 10,000 and treats 3.5 million gallons of wastewater per day. The main purpose of the system is to reduce the phosphorus content being discharged into the Lake. The System does not actually treat wastewater in the winter. The duckweed becomes dormant and sinks to the bottom of the six-feet-deep waters. The System fills all winter, and discharges all summer.

THE LEMNA CORPORATION

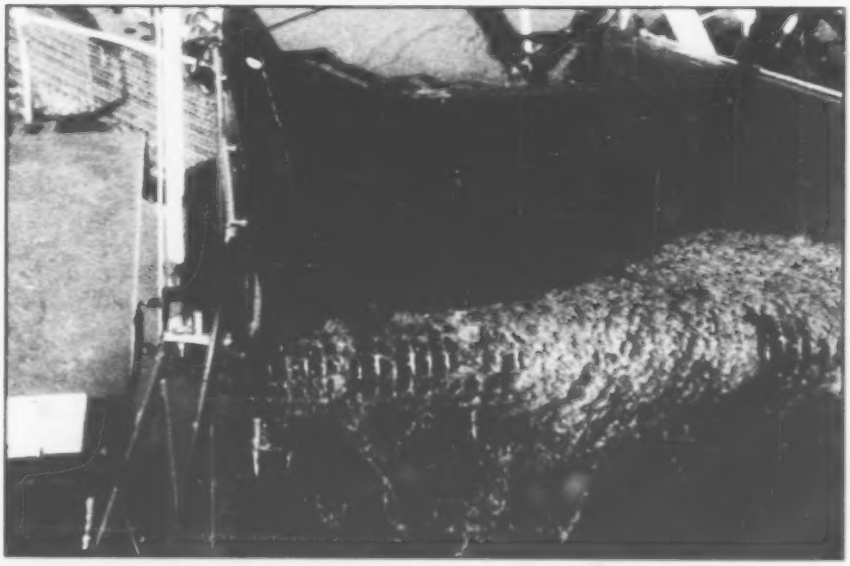
Lemna Corporation President and CEO Viet Ngo says his wastewater treatment systems are "a marriage of technology and design."

"We started over 10 years ago when we decided better technology was needed to take care of our increasing water problems," Ngo said.

Ngo, who is both a civil engineer and an artist, had envisioned the Lemna Systems to be both effective and appealing. Most Lemna Systems have park-like surroundings and areas for the public to enjoy and study the systems.

Ngo said the corporation will continue to help cities like Devils Lake solve their wastewater treatment problems using nature and that small plant.

"[The Systems] work with Mother Nature rather than complicated machinery," Ngo said. "The need for this is apparent." ■



The duckweed harvests are often used by local ranchers as nutritious silage for livestock.

CONSERVATION

BY KATHLEEN RUDE

Reprinted with permission from ©Ducks Unlimited, Inc.

A SWEET DEAL

The treatment and disposal of wastewater is usually a sour subject for most industries. In North Dakota, however, one sugar refinery has found a way to sweeten the deal, for itself and for wetland wildlife, by doing what comes naturally.

The Red River Valley straddles the eastern border of North Dakota and Minnesota. Its rich soils and extremely flat surface make this valley one of the most fertile farming areas in the country, and the most heavily populated region of North Dakota.

The American Crystal Sugar Company moved into the Red River Valley in 1926, and currently operates five refineries here. In a good year, American Crystal converts over six million tons of raw sugar beets into 1.75 billion pounds of refined sugar. That's enough sugar to fill 9,200 freight cars that, end-to-end, would form a train 94 miles long. That's also 10 to 12 percent of U.S. sugar production.

Under ownership of sugar beet growers since 1973, American Crystal is the first sugar cooperative in the United States. Beginning this year, the farmer-owned company will be the first to treat its wastewater with a series of wetlands constructed for that purpose. Fortunately, these wetlands were also designed with ducks in mind.

This novel approach to treating industrial wastewater is being practiced at the company's newest plant in Hillsboro, North Dakota. As it turns sugar beets into table sugar, this plant discharges 300,000 gallons of wastewater each day during its 185-day processing season. This water contains high concentrations of organic material, including nitrogen and phosphorus. According to Pete Anderson, factory chemist for the company, the existing water treatment facility on premises cannot handle the volume of water or the concentrations of pollutants. Anderson says that even after treatment, the wastewater often contains pollutants four times higher than allowed by the U.S. Environmental Protection Agency's water quality standards. It also carries rather unpleasant odors. Since the water isn't clean enough to be discharged back into the nearby Goose River, American Crystal has been forced to store the water in a reservoir until a better treatment method can be found.

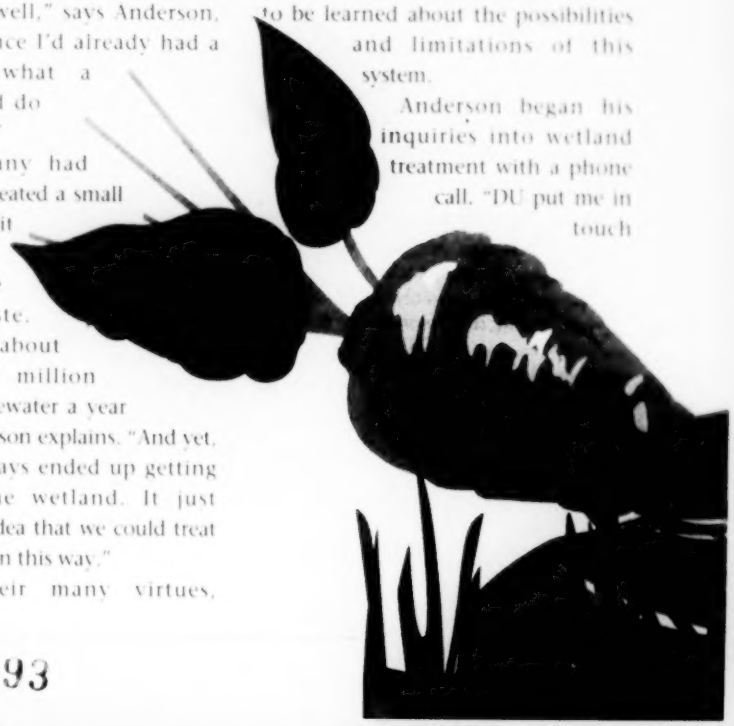
Thanks to Pete Anderson, the cooperative has found an answer that is both effective and economical. "I read an article in a 1986 issue of *Ducks Unlimited* that talked about treating municipal wastewater with constructed wetlands. I thought maybe that could work here as well," says Anderson, "especially since I'd already had a glimpse of what a wetland could do with our waste."

The company had inadvertently created a small wetland when it set up a dike to contain some beet pulp waste. "We pumped about eight to ten million gallons of wastewater a year in there," Anderson explains. "And yet, that water always ended up getting cleaner in the wetland. It just reinforced the idea that we could treat all of our water in this way."

Among their many virtues, naturally occurring wetlands have an amazing capacity to improve the quality of water flowing into them. Suspended sediments and other particulate matter settle out once the water flow comes to rest in the wetland. Marsh plants, such as cattail, bulrush and duck weed, readily absorb nutrients, including nitrogen and phosphorus, which at high levels become pollutants. These nutrients are essential for plant growth. Cattails can also accumulate heavy metals and other contaminants.

Recognizing a natural wetland's remarkable ability to cleanse water, researchers are trying to imitate that process with constructed, "artificial" wetlands. Most of the research and actual applications to date involve wetlands that treat municipal wastewater from small communities. Industrial applications, in particular, present a whole new arena of possibilities and challenges. Wetland treatment is a new technology and is not an exact science. Much still needs to be learned about the possibilities and limitations of this system.

Anderson began his inquiries into wetland treatment with a phone call. "DU put me in touch



with the right people at the Tennessee Valley Authority who eventually helped us design the system we're installing," says Anderson.

Construction began in November 1989, and four wetland cells have been completed to date; two are eight acres in size and the other two are twelve acres. In the middle of each 12-acre cell sits an island, constructed for the sole purpose of providing waterfowl with safe places to nest. The islands were designed with technical assistance from Ducks Unlimited. Cattail and bulrush are the dominant species planted here, but Anderson will increase the diversity this coming year. When completed in 1992, the entire wetland complex will encompass 160 acres, with seven nesting islands, and will have the capacity to treat 1.5 million gallons per day.

The wetland system will not replace the conventional treatment process currently used at the plant. It will supplement it. Anderson explains that the wastewater will still undergo primary and secondary treatment, where water is mechanically aerated and clarified by settling. Only then will it move into the marshes for its final, or tertiary, cleaning.

The 160-acre wetland system will cost American Crystal approximately $1.3 million to construct. According to Anderson, this is quite a savings when compared to the alternative. The company would have to pay about $5 million to construct a comparable tertiary treatment system.

Anderson has already run several million gallons through two wetland cells, primarily to establish plant growth. "I've tested the water quality in one of the cells," he says, "and it's already below EPA standards. And that's without the full system being in place yet!" He will begin water treatment on a limited basis this summer.

Anderson is equally excited about the response the wetlands have received from prairie waterfowl and shorebirds. They didn't need an invitation. Throughout last summer, several hundred ducks dabbled in the site to feed. The nesting island attracted mallard and blue-winged teal hens. With a water barrier to protect them from predators, the hens raised 60 ducklings by summer's end. When lower water levels exposed mudflats, hundreds of shorebirds flocked to these wetlands for an invertebrate feast.

"The birds really moved into the marshes right away," says Anderson. "The natural wetlands in the valley are really dry, so these marshes can help out some wildlife." An outdoorsman and hunter, Anderson wanted to make these wetlands attractive to wildlife as well as effective in cleaning up pollutants. "The nesting islands don't take away from treatment efficiency," he says. "I see them as an extra benefit of the project. Quite a few of our employees come down to the marshes to watch waterfowl."

Combining wastewater treatment with wildlife makes a lot of sense on these wetlands. American Crystal's wastewater is ideal because it contains mostly organic pollutants that are readily absorbed by marsh plants. It is free of heavy metals and toxic chemicals. As long as the company does not exceed the wetland's capacity to absorb nutrients, waterfowl and other wildlife should flourish in these marshes.

Depending on the types of contaminants present, wetland treatment systems may not always be beneficial for wildlife. Little or no research has been done on the short-term or long-term impacts of using artificial wetlands to treat wastewater containing heavy metals or toxic substances. The same holds true for studies addressing impacts to wildlife living in those types of wetlands.

Anderson says the wetland project is going so well at Hillsboro, the company is considering a similar system at a plant further north. Finding enough land to build a wetland complex is not a problem here, but space does prohibit the company from developing wetland treatment systems on two other plants located closer to urban areas.

Concerned about meeting standards for discharging wastewater in the valley, other sugar companies are evaluating their treatment systems, and are paying close attention to American Crystal's progress in the wetlands arena. From all indications, it appears to be a sweet deal that'll be hard to beet.

BEST COPY AVAILABLE